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PRODUCT ENGINEERING

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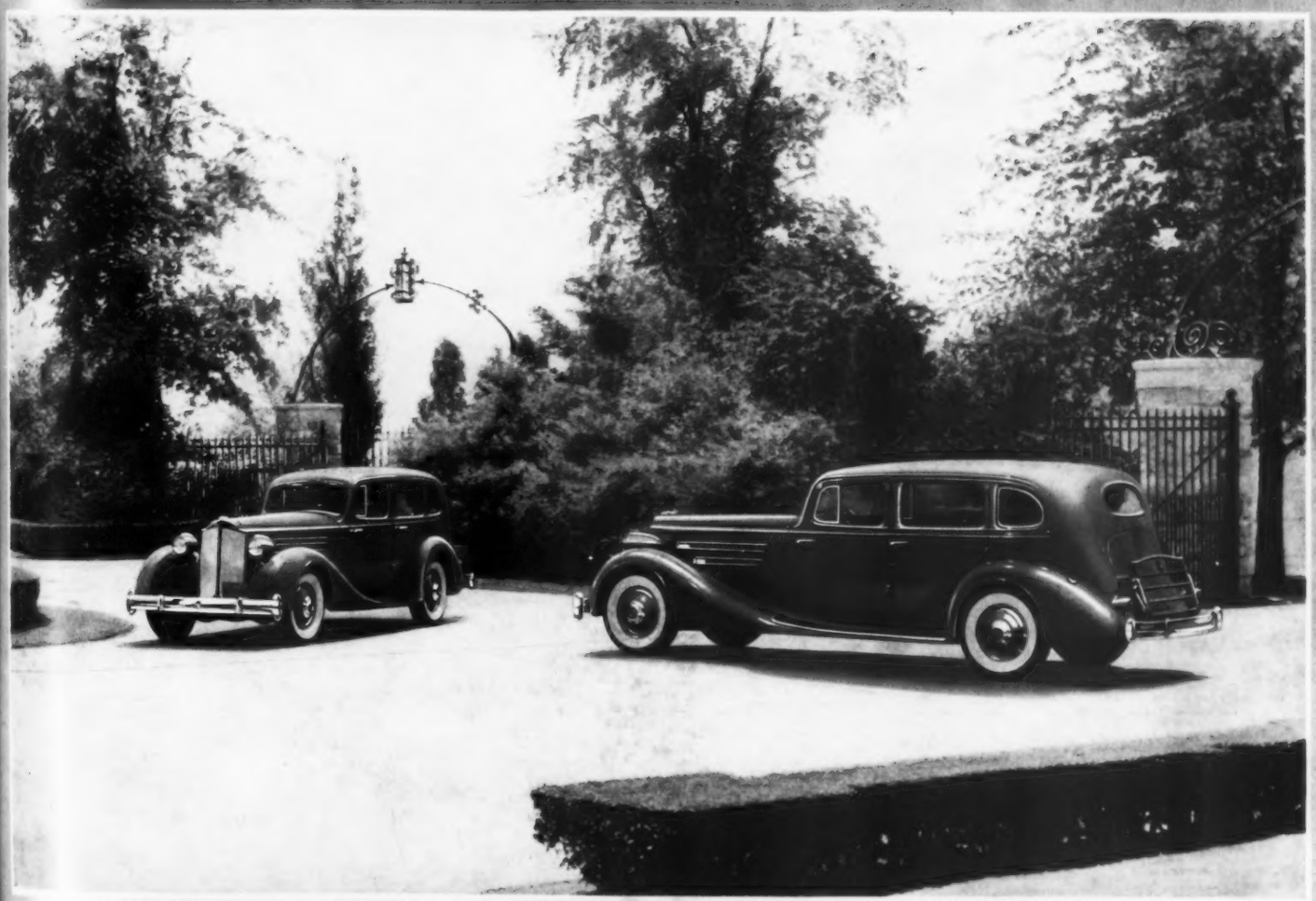

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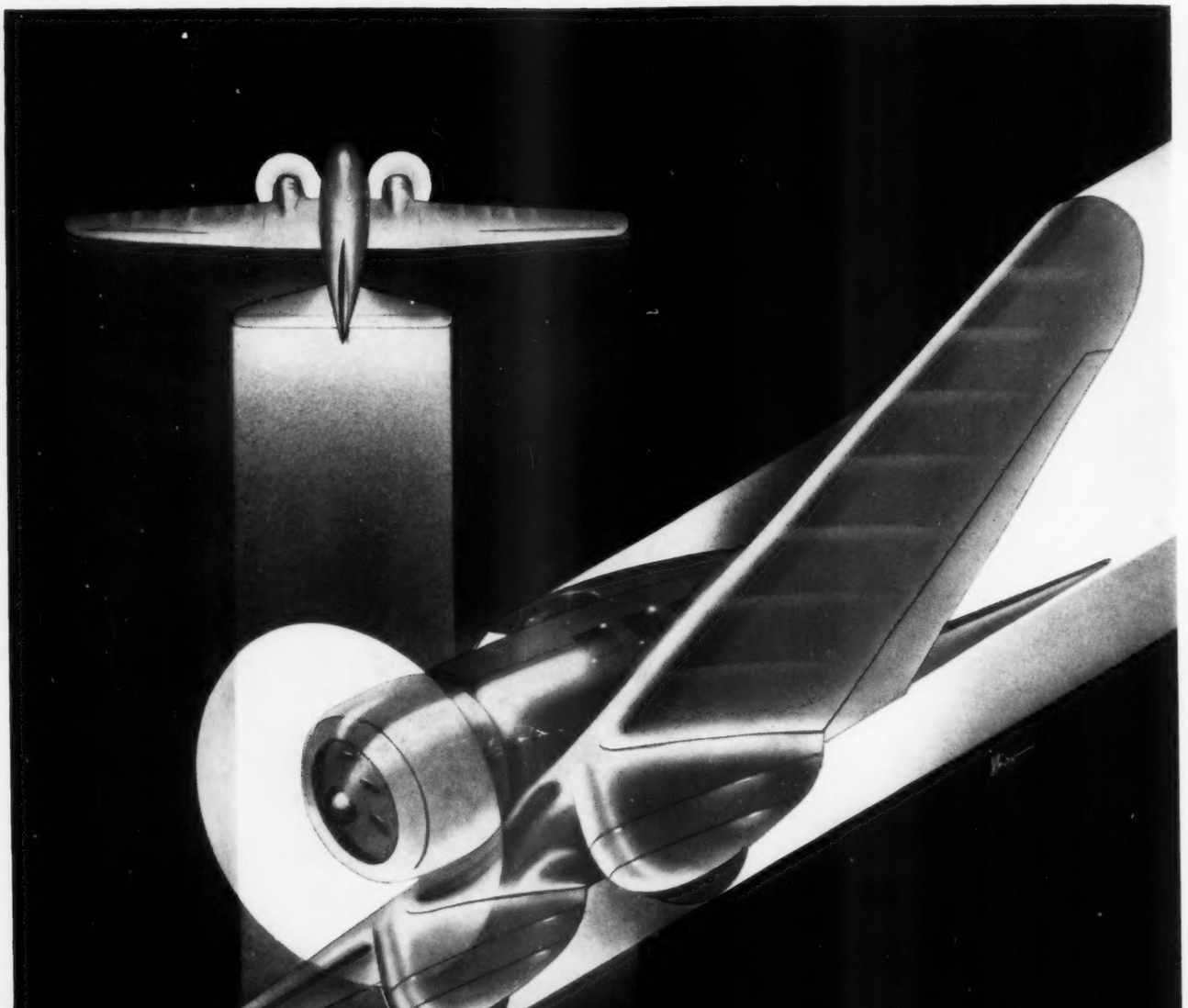

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PRODUCT ENGINEERING

VOLUME 6 NUMBER 8

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Next Month

Part II of the series on hydraulic controls.—In a three-page article T. L. Robinson, technical vice-president of McGill Manufacturing Company, shows typical applications of anti-friction bearings that are special as to shape, material or dimensions, and gives the data required by the designer who may want to use special bearings in his machine.—Other articles include machinery drives, thermostat operated mechanisms, and the third of our series of color articles—in color.

Starting with this issue we inaugurate a new feature—color illustrations.

COVER PICTURE

"Fresh from its 250-mile final test run, the new Packard Twelve leaves the Packard proving grounds, ready for your immediate motoring pleasure." *(Courtesy Packard Motor Car Company)*

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Intimate Correspondence

Our Apologies

PRODUCT ENGINEERING
NEW YORK

The July issue of *Product Engineering*, page 272 carries the paragraph headed "Plating without Polishing" and it is stated therein that this new process is claimed to be one of the most important advances yet made in the art of plating.

There must be many, like myself, who are wondering how this English "Bright Nickel" process differs from some of those now in use in this country, as exemplified by the Harshaw and the McGean solutions.

For the benefit of your subscribers who are vitally interested in plating improvements, will you not give us some further details? —H.D.S.

Bristol, Conn.

WE must apologize for having presented an incomplete item in our news section in that we did not give the desired details concerning this process. And since publishing the item we uncovered advances in this country.

For the benefit of our subscribers we are going to go the suggestion of H.D.S. one better. We have induced a well-recognized authority on the electrodeposition of metal, to write an article on these latest developments in this field.

A Request Anticipated

PRODUCT ENGINEERING
NEW YORK

Would like to have more dope on enamel and enameled parts. —H.B.H.

Milwaukee, Wis.

A TIMELY request, because we have just completed our plans to present "Finishing Schedules," beginning with the September number. These "Finishing Schedules" will give the specifications for finishing various products, such as refrigerators, household equipment, etc. Different specifications will cover lacquers, enamels, plating, and the various other finishing processes.

More Oilless Bearings

PRODUCT ENGINEERING
NEW YORK

I would like to see articles on the design of automotive bearings that are fool-proof, oilless, non-rusting and completely sealed units. That is, couldn't you give us an article showing typical designs of such bearings, where to use them, and their advantages and disadvantages? —C.R.Z.

Highland, Ill.

A GOOD suggestion. Just now such an article is not in our editorial budget, but we are planning to procure one for an early issue and have requested an authority on bearings to write it for *Product Engineering*.

Again We Beat the Gun

PRODUCT ENGINEERING
NEW YORK

I hope the next article on color will be illustrated with color. It seems to me that a magazine that talks so much about the product appeal and sales value of color would practice what it preaches.

Another thing that I would be interested in seeing in *Product Engineering* would be articles outlining the correct and incorrect choice of materials for various jobs, especially with reference to stainless steels and new ferrous and non-ferrous alloys.

—H.E.H.

Bloomfield, N. J.

WE cannot always practice what we preach, but in this instance *Product Engineering* delivers the goods. With this issue we start our four-page insert, printed in four colors.

Editors and Advertisers Compete

PRODUCT ENGINEERING
NEW YORK

Undoubtedly many of your readers found the articles "Designing Chain Drives" interesting and valuable, but personally I have no use for such articles.

The section that I always read first is the New Materials & Parts. In the July number I found the articles "Product Appeal Through Correct Colors" and "Thermostatic Mechanisms" of particular interest. But aside from this, I find the ads always clean-cut. One does not have to study long to get the idea being sold. This, together with the excellent printing, makes the magazine especially attractive to me. —P.S.B.

Dowagiac, Mich.

COMPARISONS are often odious, but in this instance we must admit that we agree in principle with P.S.B. with reference to his comments on the appearance of our advertising section. Frankly, we editors have no control over it and therefore cannot take any credit for it. But, at the same time it gives us stiff competition and an added incentive. We hope that P.S.B. can also say that one does not have to study the articles very long to get the ideas being "put across."

More on Materials

PRODUCT ENGINEERING
NEW YORK

I would like to see included in *Product Engineering* more articles on new metal alloys, with comparative data such as strength and chemical composition. There is also the question of the bearing qualities of various alloys, lubrication requirements, etc. I would be pleased to see articles on these subjects in some of the early issues. —G.P.

Los Angeles, Calif.

WE must confess that there is a dearth of articles in this present number on the subject of metals and alloys. But in order to keep our "editorial coverage" this is unavoidable. However, the October number will make up for it by featuring a number of articles on metals, including one on comparative data on some of the non-ferrous alloys and one on lubrication. We hope that the October number will partially satisfy the appetite of those of our readers who, like G. P., want more data on materials and lubrication.

Data Wanted on Pressed Sections

PRODUCT ENGINEERING
NEW YORK

Quite a number of articles have appeared in *Product Engineering* on the use of pressed steel. But none of the articles that I have seen so far give any data on the moment of inertia, section modulus or other strength factors for pressed steel channels, angles and other sections. Can you advise me where I might procure such data?

R.P.A.

Fort Worth, Texas

WE admit that it is quite a task to calculate a section modulus and moment of inertia of pressed steel sections. We have had various articles in the past in *Product Engineering* showing how to calculate the moment of inertia of irregular sections and there is much information on this subject in standard handbooks and text books.

Until manufacturers of pressed steel channels and other sections standardize the dimensions it would be impractical to publish tables of moments of inertia for such sections. However, undoubtedly the manufacturers of steel channels have available tables giving the properties of the sections that they manufacture. We therefore suggest to R.P.A. that he get in touch with some of the leading manufacturers of pressed steel sections to give him the data.

PRODUCT ENGINEERING

GEORGE F. NORDENHOLT, *Editor*

MCGRAW-HILL PUBLISHING CO., INC. AUGUST 1935 VOLUME SIX, NUMBER EIGHT

The Responsibility of Professors

GENERALLY throughout Europe college and university professors are respected and honored; they are often envied for the coveted position they occupy. But in the United States, although individual professors may be highly esteemed, the profession does not command the respect it should. Many people, even university graduates, deride the college prof; often he is the subject of a cartoon. Why is it that in Germany the university teachers are given a place of honor while in this country they are often considered as a joke?

One common criticism aimed at college professors is that, never having faced the hard facts of commercial competition, they are completely impractical in their conceptions of the world of business. They are idealists. But this criticism cannot be applied to many of the teachers of engineering for among them we find former plant superintendents and men who have seen years of service in engineering departments. Many of these men have retained their contacts with industry by serving some company or other in a consulting capacity. Thus they keep in touch with progress and maintain a true perspective of life as it actually is.

But it requires only a few misguided professors to subject the whole profession to ridicule. This may occur when a few of the "hot house reared" college profs allow themselves to be publicized as sponsoring or supporting a dubious cause. Professional publicists often call upon unsuspecting college profs to give their support to causes that do not serve society nor deserve the attention of college professors.

The manner in which university professors sometimes permit the use of their name to the detriment of the dignity of their profession and the status of the university they serve is sometimes nothing less than stupid. Thus the names of the members of the advisory board of the American Economic Foundation include six college professors. Some of them admitted upon inquiry that they did not even know who are the financial supporters of the organization which they publicly endorsed by permitting themselves to be induced to serve on its "advisory" board.

The director of the American Foundation is well known as a professional organizer. And the published aims and purposes of the American Economic Foundation are mere generalizations. It now develops that the financial support for this "foundation" is being furnished by a number of companies that are or recently have been involved in patent controversies or patent litigation. With this knowledge, any right thinking man would suspect an ulterior motive. It is hard to understand why these college profs endorsed an organization about which they apparently knew so little. By doing so they invited upon themselves and their profession, scorn and derision.

Colleges and universities should not permit faculty members to lend their name to doubtful causes. And the university professors should denounce those individuals of their profession who give cause for ridicule, as in the instance described here. This would do much to give the profession the position of honor and dignity that it deserves, and which so many of its members have earned.

Modern Hydraulic Systems for Operating

ALONG with its increasing application to machine tools, there have been many developments in applying hydraulic operation to other types of machinery. Analogous to feeding, clamping, reversing, indexing and shifting operations on machine tools, hydraulic power is being used for holding down and positioning moldboards on bulldozers, scrapers, snowplows and other road building and maintaining machines. Heavy road rollers are being steered hydraulically and their scarifier attachments are being operated in a like manner. Hydraulic operating units are being applied to dump truck bodies, shop trucks, farming and mining machinery, concrete mixers, winches and conveyors.

The popularity of hydraulic operation as applied to this variety of machinery probably can be attributed to its efficiency, simplicity and flexibility. Ability to withstand overloads without damage as might befall complicated mechanisms, transmissions or driving units

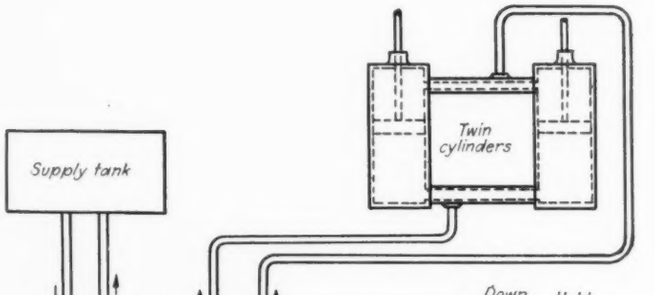


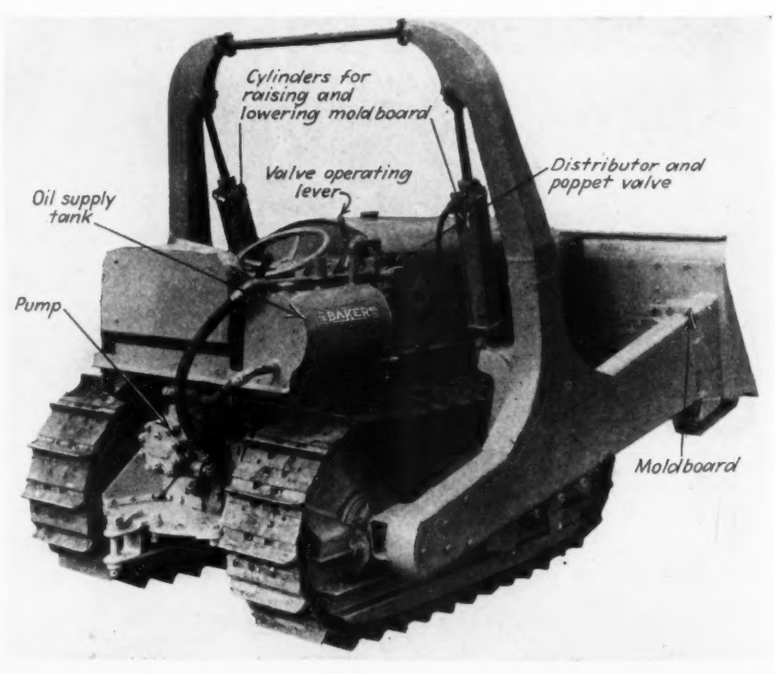
Fig. 1—Bulldozer of the Baker Manufacturing Company and the hydraulic circuit for raising, lowering or holding fixed the moldboard or allowing it to float. The machine is on an Allis-Chalmers tractor

is another advantage. Usually the change to hydraulic operation eliminates numerous gears, cams, clutches, levers, splined shafts, pulleys, chains, belts, or other mechanical units. Thereby, a simpler, more compact and less costly machine can be designed. Hydraulic operating pressure can be adjusted readily; the pumps are simple and compact, and the system is easy to maintain.

An example of hydraulically operated road machinery is the Bulldozer made by the Baker Manufacturing Company for moving earth, grading or plowing snow. As shown in Fig. 1, the frame that carries the moldboard is pivoted at the rear axle of the Allis-Chalmers tractor, and is actuated by two hydraulic cylinders.

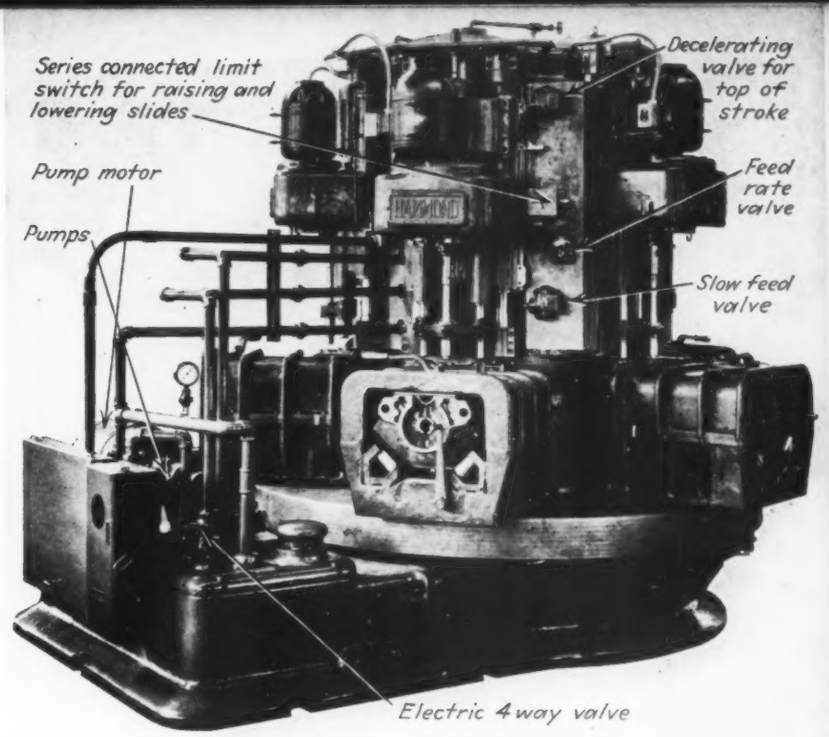
It can readily be seen that it would not be practical to provide a means for raising and lowering the moldboard at only one point, midway between the two arms of the frame. This would have necessitated an extremely heavy saddle to hold the frame rigid against the unbalanced loads. Logical design dictated that the force for lifting had to be applied at each arm. And because hydraulic cylinders would, among other advantages, assure equal lifting force at both arms, this type of design was selected.

A Roper herringbone gear type of pump, rated at 1,000 lb. per sq.in. pressure, draws the oil from the supply tank and delivers it to a distributing valve. This valve is a combination cylinder distributor, poppet and relief valve built in one unit. It allows the moldboard to be raised or lowered, to float or to be held in a fixed position. When closed, the poppet valve locks the oil in the working cylinders, thereby preventing movement of the piston and thus holding the moldboard in a fixed position. Moving the control lever to the up, down or floating position rotates the distributor valve sleeve.



Machinery—I

First of two articles illustrating hydraulic controls and operating mechanisms applied to machine tools, road-building machinery, automotive, marine and other applications


Series connected limit switch for raising and lowering slides
Decelerating valve for top of stroke
Pump motor
Feed rate valve
Pumps
Slow feed valve
Electric 4 way valve

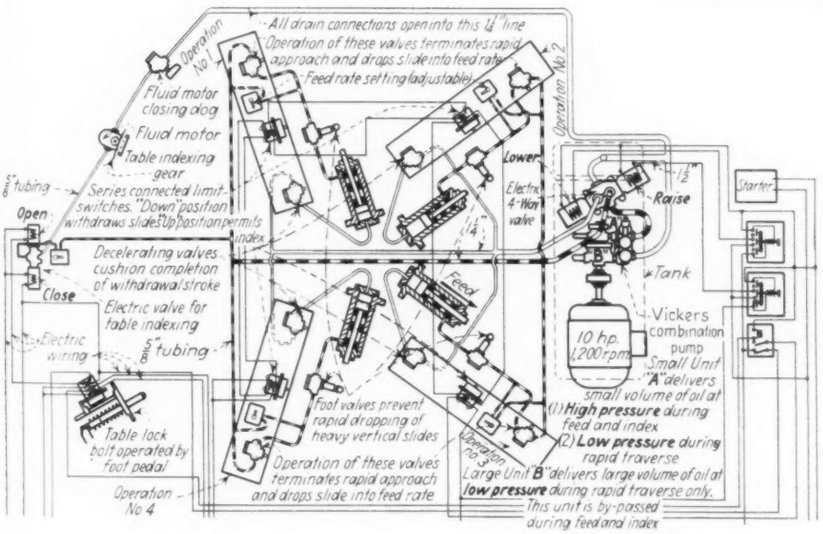

All drain connections open into this 1¼" line
Operation No. 1
Operation of these valves terminates rapid approach and drops slide into feed rate
Feed rate setting (adjustable)
Operation No. 2
Fluid motor closing dog
Fluid motor
Table indexing gear
Series connected limit switches. "Down" position withdraws slides. "Up" position permits index
Lower
Electric 4-Way valve
Raise
Starter
Open
Close
Decelerating valves cushion completion of withdrawal stroke
Feed
Tank
Electric valve for table indexing
Vickers combination pump
10 hp. 1,200 rpm
Small Unit "A" delivers small volume of oil at
(1) High pressure during feed and index
(2) Low pressure during rapid traverse
Electric wiring
Foot valves prevent rapid dropping of heavy vertical slides
Table lock bolt operated by foot pedal
Operation of these valves terminates rapid approach and drops slide into feed rate
Operation No. 3
Large Unit "B" delivers large volume of oil at low pressure during rapid traverse only.
This unit is by-passed during feed and index
Operation No. 4

Fig. 2—A 5-station boring and reaming machine made by the Hammond Manufacturing Company. The hydraulic and electrical circuits with solenoid operated hydraulic 4-way valves for table indexing and tool feed and return, are shown in the diagram to the left

A cam moves it axially, opening the poppet valve.

A normal operating pressure of 125 to 300 lb. per sq.in. is required, the relief valve being adjusted for 500 lb. per sq.in. to permit building up to that pressure to take care of momentary overloads. The poppet and relief valves and their seats, and the gears in the pump, are made of Nitralloy to resist abrasion.

Seamless tubing is used for the two cylinders for raising and lowering the moldboard. The piston packings are of the conventional double-acting cup leather type and are backed up with heel leather for support. A V-type of packing ring is used for the piston rods.

One of the latest hydraulic developments is its use for indexing. In the 5-station vertical boring and reaming machine shown in Fig. 2, built by the Hammond Manufacturing Company, not only is the heavily loaded table indexed hydraulically, but the multiple tool sliding heads are also moved hydraulically. Solenoid operated hydraulic valves are used, greatly simplifying the control system by the elimination of many rods and levers.

The table lock bolt is withdrawn manually by depressing a foot pedal. This movement also closes an electric switch that controls the solenoid operated valve, causing it to open. This starts the hydraulic indexing motor which is geared directly to the table. To overcome friction and to get smooth operation, the 95-in. table is mounted on a Bantam ball thrust bearing 54 in. O.D. and 4½ in. thick.

Rotation of the massive table must be decelerated gradually. This is done by dogs which are mounted on the underside of the table and close the fluid motor shut-off valve. This causes the oil to back up in the fluid motor, acting as a brake to decelerate the speed of table rotation. When the table stops the movement of the lock bolt, coming into engagement causes an electric circuit to be closed. This opens a solenoid operated valve, thus automatically advancing the four independent sliding heads.

Because two different operating pressures are required, one for indexing and tool cutting and a lower one for returning the sliding heads, a Vickers combination pump, driven by a 10-hp., 1,200-r.p.m. motor, is used. This combination pump consists of two pump units mounted on a common shaft, each unit being equipped with an individual relief valve. A mechanical means is provided for by-passing the discharge of the larger unit to atmospheric pressure during certain periods of the cycle. Both pump units operate continuously. The small unit *A* delivers a small volume of oil at high pressure, the relief being set for 500 lb. per sq.in. The large unit *B* delivers a large quantity of oil. Its relief valve is so set that when pressure in

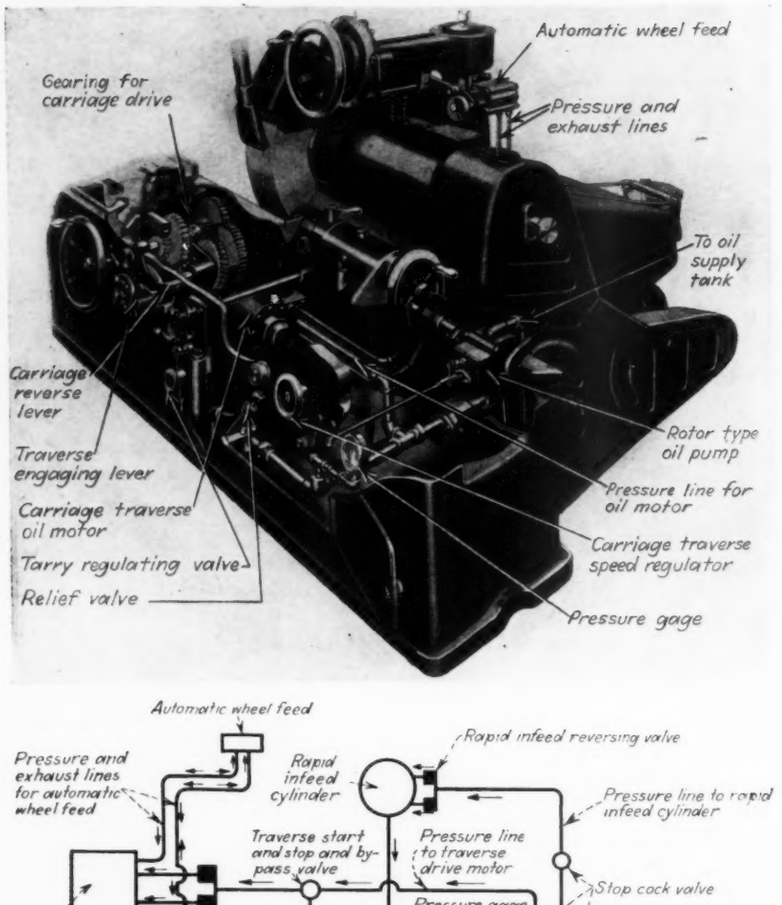


Fig. 3—Landis Tool Company, Type B cylindrical, external grinder with hydraulic circuit for operating work carriage, automatic wheel feed and rapid wheel in-feed shown in the diagram. A variable displacement rotor pump furnishes only the required amount of oil to the carriage traverse liquid motor

the discharge line builds up to 250 lb. per sq.in., the discharge of the unit *B* is opened to the tank at atmospheric pressure, and only unit *A* is delivering oil to the machine. During the feed and index period, the operating pressure is built up by the resistance encountered and the large pump automatically discharges at atmospheric pressure.

Oil from the pump is delivered to the electrically operated 4-way valve which controls the directional flow of oil for raising and lowering the sliding heads. When the solenoid marked "raise" is energized the oil under pressure is delivered to the bottom or rod side of the piston causing the heads to be raised. When the solenoid marked "lower" is energized, oil under pressure is delivered to the top of the piston, causing the head to advance downward.

Each sliding head is equipped with four dogs for operating the hydraulic and electric circuits. The upper dog operates the upper decelerating valve which cushions the impact at the completion of the withdrawal stroke by gradually closing the oil flow out of the head end of the cylinder. Independent of this, the valve can also be operated manually so that the pistons can be moved downward whether the valve is open or closed.

At the completion of the feed stroke, the upper of two other dogs shifts a limit switch downward to energize the "raise" solenoid of the 4-way valve to withdraw the slide. At the completion of the withdrawal stroke the lower of these two dogs shifts the limit switch upward to close the relay which permits indexing.

On the feed stroke, the lower dog on the slide closes the lower valve to stop the rapid advance of the head as it reaches the work. This valve is held closed during the entire feed period, the oil being delivered to the feed cylinder only as fast as the adjustable metering valve will permit the oil to flow. At the end of the feed the tools dwell momentarily for clean-up of the cut and then are withdrawn automatically at a rapid traverse rate.

The sliding heads are mounted on hardened and ground guide bars, each head being equipped with an integral pump for pressure lubrication and with a floating bushing plate that is dash-pot actuated. In addition to the master lock bolt, 8 auxiliary lock bolts and 4 guide bushings must register with the holding fixtures at each indexing operation.

Two types of hydraulic systems, type B and C, are used on the cylindrical grinders manufactured by the Landis Tool Company. The type B system, Fig. 3, is driven by a low-pressure, variable flow rotor pump operating at approximately 250 lb. per sq.in. pressure. Used in conjunction with this variable flow pump is a continuous hydraulic oil motor of Landis design for driving the work carriage. The variable delivery pump furnishes only the required amount of oil for operating to avoid excessive heating of the oil, as might occur if the oil is by-passed continuously through a relief valve.

From the pump, the oil goes through a by-pass valve and a balanced-piston type reversing valve and then to the continuous oil motor for traversing the work carriage. The by-pass valve is connected with the traverse start and stop lever in such a manner that when the carraige traversal is stopped, the oil coming from the pump is by-passed back to the oil reservoir.

The oil motor is of the 2-chamber type, having two rotors keyed to the same shaft, and set 180 deg. apart. Oil enters the two chambers simultaneously from the reversing valve and as the rotor blades seal direct-connection with the exhaust port, pressure is exerted against the rotors, causing them to rotate. When the

rotors pass the exhaust ports the cycle is completed, the oil being returned to the reservoir. A steel worm on the end of the oil motor shaft transmits the power to a rack on the under side of the carriage through a bronze worm gear and pinion. The work carriage has a maximum traverse movement of 240 in. per min. The motor is cut out for hand traversal of carriage.

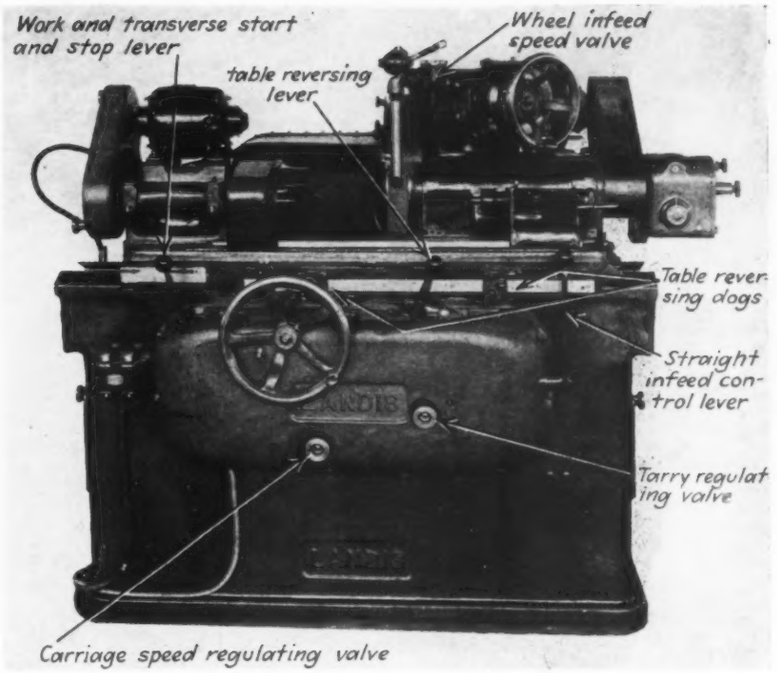
An automatic hydraulic feed mechanism feeds the grinding wheel into the work. It is operated by a small rotary oil motor located on the top of the wheel head. At the reversal of the work carriage, a small cam on the end of this motor rotates and trips the feed pawl which engages the feed wheel.

Although not shown in the photograph, the grinding wheel head can be equipped with a rapid straight in-feed, hydraulically operated, shown at the top center of the diagram. The wheel-head is mounted on a sub-slide actuated by a piston and cylinder mounted beneath the slide. The oil flows directly from the oil pump to the reversing valve. By manipulation of this valve, the oil is admitted to the cylinder, causing the wheel to approach or recede from the work at a rapid rate of speed. The wheel continues to approach rapidly until it is about to contact the work, when a lug on the under side of the sub-slide contacts a feed control piston. As there is oil resistance ahead of the feed control piston, the grinding wheel-head slows down, continuing to feed the wheel slowly into the work until the piston rod contacts a positive stop when the work has been ground to size.

The type C Landis 6-in. and 10-in. external grinders are provided with a different hydraulic system, as shown in Fig. 4. A constant speed gear type of pump instead of a variable flow rotor pump supplies the system with oil at 200-lb. per sq.in. pressure. The carriage is actuated and reversed by two opposed hydraulic cylinders thereby eliminating the oil motor as used on the type B machine shown in Fig. 3. Because two cylinders are used, four chambers are available, of which two are for power and two for control. The volume of the oil is constant, regardless of the direction of traverse. A control valve governs the flow of oil from the end of one cylinder to the corresponding end of the other cylinder. Piston type valves are operated by two reversing dogs fastened on the carriage. A relief valve is screw adjusted for the proper line pressure.

The automatic in-feed of the grinding wheel is operated hydraulically by a small piston at the rear of the feed hand wheel and functions at each reversal of the table. The in-feed can also be actuated at one end of the carriage reverse stroke if desired.

As the work and traverse start and stop lever is moved to the left, the limit switch starts the work-head motor. Continuing this movement of the lever moves the by-pass valve to the right, thus closing the by-pass


Work and transverse start and stop lever
Wheel infeed speed valve
table reversing lever
Table reversing dogs
Straight infeed control lever
Tarry regulating valve
Carriage speed regulating valve

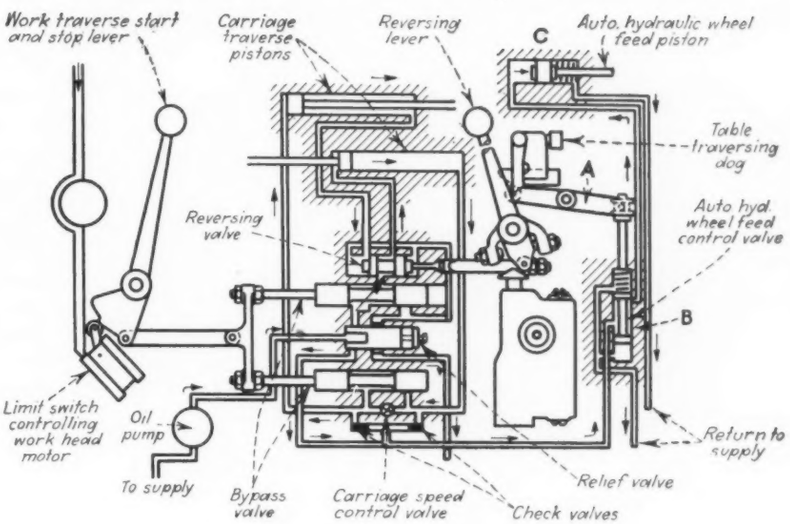


Fig. 4—Type C Landis Tool Company grinder with a hydraulically-operated tarry mechanism to give a dwell at each end of the traverse stroke. As shown in the circuit diagram, the work carriage is actuated by two opposed hydraulic cylinders in which the volume of oil is constant

ports. The oil is drawn from the tank to the oil pump and relief valve to the carriage traverse system, at the same time sending oil to the automatic hydraulic wheel feed control valve. As the table dog comes in contact with the reversing lever the movement of this lever carries the reversing valve to a neutral position, thus stopping the carriage. The spring-pressed, inverted V-plunger urges the reversing lever to continue its movement. This movement is controlled and timed by a tarry mechanism which determines the length of dwell of the carriage which can be adjusted by the control valve from zero to any amount required. Just before the table dog shifts the reversing lever, the automatic feed cam contacts lever *A* operating the valve *B*, which actuates the piston *C*, causing the wheel base to feed.

PRODUCT DEVELOPMENTS

Fine Appearance Without Complication

● As a heater, the former model of the Kalamazoo stove, shown to the right in the illustration below, performed satisfactorily, and a large number were sold to rural buyers over a period of years. However, new radios, modern automobiles and displays such as the Century of Progress have made rural communities style-conscious. Farmers now demand better appearance, but at no sacrifice in performance and no increase in cost.

The former model of the Kalamazoo stove was designed using castings assembled into a demountable unit for mail order shipment, and a redesign necessarily called for castings. In the new design shown to the left, developed by the Wilbur Henry Adams Associates, not only was the appearance modernized, but the number of separate castings was reduced, simplifying shipping and assembly operations.

The structural shell of the heater is built up of four similar corner castings and two identical side castings. Front and rear castings are also similar, the front being fitted with a door while the rear casting has the chimney outlet and a small door giving access to the water tank. The base and top are one-piece castings which overlap the joints made with the sides.

By using fluted castings on all four sides, increased radiating surface is obtained, at the same time adding contrast to the plain corner castings. Air circulation past the fire pot within the inclosure is obtained through openings in the lower portion of the fluted panels and the grill cast into the top. For better appearance from the front, the ash door is placed on the right side, and the fire box door in the front is fluted to match the front panel.

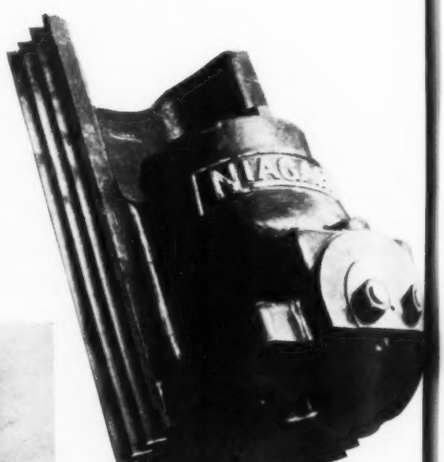
To withstand the heat, a porcelain enamel finish is used, the base being dark brown with a lighter shade of brown for the sides and top. Mica windows in the old model were eliminated because of difficulties in replacement. Most users, it was found, opened the door anyway to look at the fire.

The cost of the new stove is approximately the same as for the old model. Increased sales are reported for the redesigned stove, although the new model has been on the market but a short time.

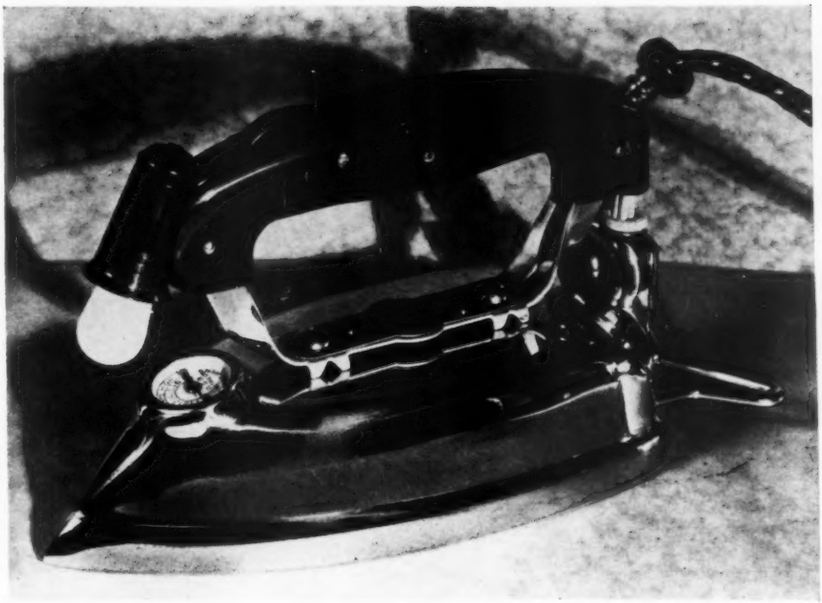
Attractive appearance of the new model Kalamazoo stove, styled by Wilbur Henry Adams Associates, reflects the improved construction which requires fewer parts

● *Rigid Press Slide*

In the crosshead for the new Niagara press, increased bearing surface as well as increased rigidity is obtained by the use of three V-gibs. Because of the shallow depth of the



Three V-gibs and large forward supports give added rigidity to the slide in the Niagara press



V, the gib bolts can be placed close to the slide, giving minimum bending stresses in the bolts.

Vertical play in the die clamp is eliminated by a breech block construction. The die clamp fits in a smooth bored hole centered slightly above the bottom of the slide to hold the block in place. To furnish solid backing for mounting dies, the forward support is strongly reinforced by extending the solid casting of the slide.

• *Temperatures Indicated For Electric Irons*

For a short "warm-up" time in electric irons, the heating element must be of larger capacity than necessary to maintain the temperature during operation. Then, to hold the working temperature constant, the current must be switched on and off.

Thermostatic elements of various types with an adjustable operating temperature are used extensively to control temperatures in irons, but in these devices the electrical contacts are subjected to the operating temperatures of the iron. In order to effectively break the relatively high current, thermostatic controls require an appreciable temperature difference between on and off positions.

In the R & R Greyhound iron illustrated, the thermostatic element serves only as an indicator, the current being controlled by a switch conveniently located on the handle. The indicator placed ahead of the handle is easily read, giving continuous indications of the temperature of the center of the sole. Illumination for the work as well as the indicator is provided by a 6 watt lamp inserted in a molded socket assembled to the front of the handle.

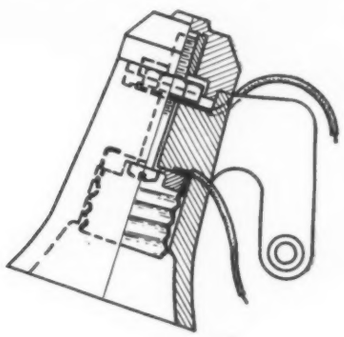
Other modern features incorporated in the design include a one-piece body casting in which the heating element is inserted from the rear. An insulated porcelain reflecting surface mounted over the heating element reflects the heat downward to the ironing surface. A built-up handle made of low-conductivity molded Durez insulates the grip from the handle frame. The handle is kept cool by ventilating slots which give increased cooling surface.

• *Random Jottings*

Built-in instruments in the new Ford laboratory test sets indicate the condition of the electrical system, compression, fuel pump, carburetor, valve timing and accessories so that proper adjustments can be made. They also provide proof to the customer that corrections are needed and show when the condition has been corrected. To make the indication of the instrument plainly visible under conditions where lighting may be uncertain, the instrument board is equipped with a built-in lamp.

In horizontal boring machines built by the Lucas Machine Tool Company, a 1½ per cent nickel cast iron is used for all beds, columns, saddles, tables and spindle heads in order to obtain high strength and rigidity. Using a nickel alloy iron, the ways have a machinable hardness higher than is obtainable with ordinary chilled gray iron, and wear is said to be more uniform.

In the R & R iron, a molded lamp socket is assembled into the built-up, ventilated handle



One nationally recognized supplier of fishing tackle now uses stainless steel for leaders, flies, rods, guides and hooks.

Cast iron and mild steel gears and plain bearings formerly used in the spindle drive in the pipe threading machines built by Landis Machine Company have been replaced by heat-treated alloy steel gears and ball bearings running in an oil bath, giving smaller machine size and increased life.

In a differential analyzer which performs intricate problems in calculus in a short time, several highly polished disks of stainless steel are used in friction drives in the mechanism.

A flat belt splicing tool designed by the Flexible Steel Lacing Company has a clamp and frame made of aluminum alloy to reduce weight. Total weight of the tool is only 4 lb. 3 oz. with this construction.

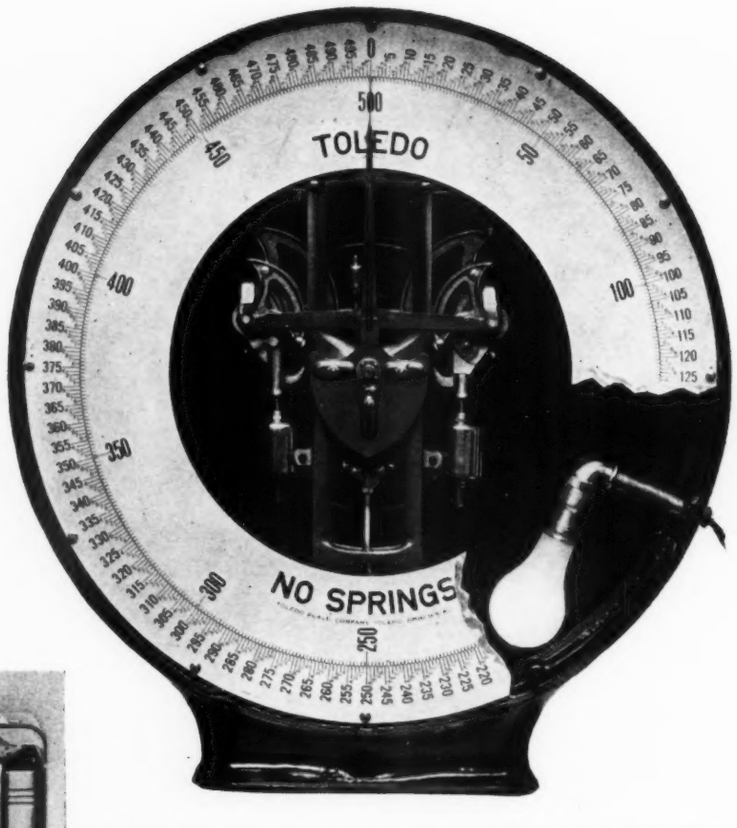
An electric garbage grinder for household use, developed by the General Electric Company, shreds refuse dropped into the device so that the garbage can be discharged

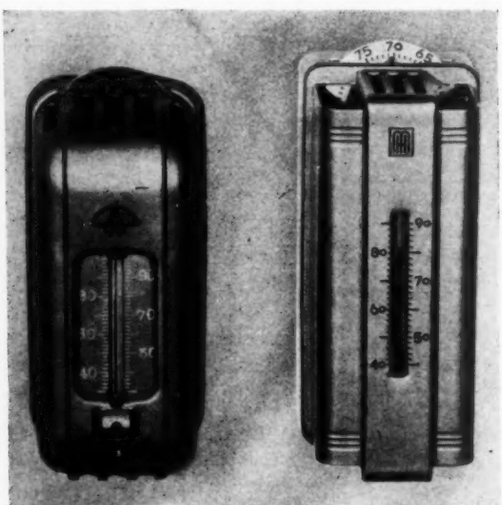
into the sewer. Grinding knives are made of Carboloy.

Two micrometers, just placed on the market, are being sold with the assurance of permanently visible rulings since stainless steel is used for the frame and measuring surfaces.

• *Spot Heaters for Scales*

Under severe atmospheric condition, changes in temperature and pressure cause housings for large scale to "breathe" with the result that moisture tends to collect on metal parts within the scale. For applications in which sweating may occur, Toledo scales are now equipped with an internal heater in the form of an ordinary electric lamp in a built-in lamp socket and support. A boss on the dial housing is drilled and tapped, and the heating unit attached from the inside of the case. Heat from a 25-watt lamp is sufficient to keep the indicating mechanism dry.





Heat from an ordinary lamp bulb prevents moisture from collecting inside Toledo scales

A stamped case (right) designed by Henry Dreyfuss houses the bimetal mechanism in the new Minneapolis-Honeywell thermostat

• *Operation and Appearance Improved*

Two entirely different problems were involved in a recent redesign of the Minneapolis-Honeywell room thermostat. The first aim was to make the thermostat more sensitive to changes in room temperature, and less affected by wall temperature and its own thermal capacity. Appearance also had to be considered. The thermostat had to be small and inconspicuous, while low production costs required the use of a stamped case with a shape and finish that would harmonize with any type of decorative scheme.

In the design of the bimetal thermostatic element, sensitivity, accuracy and low thermal capacity required the use of a tapered strip bent to a U shape. The strip was spaced away from the base to subject all of the element to the circulating air, and insulation in the base reduced the influence of wall temperature.

For a more consistent response to small changes in room temperature, ventilation in the new model was restricted to vertical flow through the instrument. Openings on all sides of the former model were replaced by a closed case open only at the top and bottom. In the new design, the chimney effect obtained by the open ends results in a more uniform response to room temperature changes, reducing the effect of drafts and air currents. Accuracy of adjustment is improved by a setting mechanism operated by a cam that eliminates back lash.

With the mechanical improvements developed, the appearance problem was turned over to Henry Dreyfuss. In his new case design shown at the right, the apparent mass of the unit is reduced by the use of a raised central panel with the stepped-out back panel. Stamping and drawing operations are simplified by a two-piece case design in which the central panel carrying the thermometer is assembled by bending over projections or tongues. To avoid the effect of radiant heat from hands or breath, the thermometer bulb is placed within the case near the bimetal element.

Designation of Surface Qualities

ROBERT J. WALKER
Lieutenant Commander, U. S. Navy

With no standard specifications available for surface quality designations, the author proposes a set of instructions for drafting room use, which could be adopted with desirable modifications. Not to be construed as official or reflecting the views of the Navy Department

WITH the increasing need for finer finishes and smaller tolerances, there is, unfortunately, no accepted standard in this country for the designation of surface qualities. As a result, various manufacturers of machinery and equipment have adopted their own standards. When no two firms use the same nomenclature for finishes, confusion and misunderstanding exists. There should be available a standard universally understood method of designating on the drawing the type of finish that the designing engineer wishes to specify.

In preparing a proposed standard, applicable material from papers already presented on the subject has been used in conjunction with what appears to be the most suitable practice followed in the drafting rooms of the Bureaus of Aeronautics, Engineering, Ordnance, and Construction and Repair, of the Navy Department, no two of which are alike. In connection with the Bureau of Aeronautics, it is interesting to note that this department uses the "U. S. Army Corp Drafting Room Manual" prepared by the Material Division, Wright Field, Dayton, Ohio.

Proposed Standard Drafting Room Designations for Finishes

The finish required on all surfaces shall be specified on all detail drawings and sketches in at least one of three places: (1) in the block that lists the bill of material, (2) along the surface line which is to be finished, or (3) by an arrow to that line. The finish shall be expressed suitably by a designation given in one of the three columns of Table I. This designation of finish shall be in accord with information given with the specifications in the block.

Machine finish is indicated by the lone symbol *f* and refers to a surface produced by finishing tools in conjunction with machines ordinarily found in the machine shop, such as lathes, planers and milling machines. This finish does not refer to the surface produced by drawing f_{dr}, or rolling operations, f_{ro}, the symbols which are also included in the table.

Rough machine finish refers to the surface produced by roughing tools with machines such as lathes, planers and milling machines.

Smooth machine finish refers to a surface produced by an exceptionally light cut taken with a broad finishing tool or with a very fine feed, in machines such as lathes, planers and milling machines.

Ground finish in its various degrees refers to the surface produced by an abrasive wheel in conjunction with machines such as external, internal, centerless or surface grinders.

Lap finish refers to the surface produced by an abrasive surface cutting with a planetary or generative motion, for finishing the inside of cylinders and surfaces of precision gages.

Polish finish refers to the surface produced by a flexible material usually impregnated or coated with a fine cutting material. When rubbed on a smooth surface this cutting material produces reflective properties, suitable for non-precision surfaces only.

Buff finish is similar to a "polish finish," but is generally accomplished with a high-speed cloth or felt wheel. The wheel may or may not be coated or impregnated with a very fine polishing compound and used for non-precision surfaces.

Cast finish refers to the surface of castings that have been thoroughly cleaned of all sand and scale, risers and gates; the fins having been cut off flush to conform to the surface of the castings.

Castings shall be graded according to the following tolerances under "ordinary castings" and "special castings." Unless otherwise specified it shall be understood that "ordinary castings" are required. Finish may be specified for either type.

Ordinary castings. The metal shall be so distributed that when the casting is completed and ready for assembly the thickness of metal shall not differ from that shown on the drawing by plus or minus 0.020 in. for a thickness of metal up to 0.40 in. and plus or minus 5 per cent of the thickness for thickness above 0.40 in. No dimensions from locating points or planes to cast

Table I—Suggested Symbols of Surface Qualities

Finish	Symbol	Limits
Machine finish	f	32/M to 0.1/M
Barked	f_b	32/M to 16/M
Very coarse	f_{cc}	16/M to 8/M
Coarse	f_c	8/M to 4/M
Very rough	f_{rr}	4/M to 2/M
Rough	f_r	2/M to 1/M
Medium	f_m	1/M to 0.5/M
Smooth	f_s	0.5/M to 0.2/M
Very smooth. (Diamond tool on brass)	f_{ss}	0.2/M to 0.1/M
Ground finish	f_g	2/M to 0.005/M or less
Rough	f_{gr}	2/M to 0.5/M
Smooth	f_{gs}	0.5/M to 0.1/M
Fine	f_{gf}	0.1/M to 0.05/M
Very fine	f_{gvf}	0.05/M to 0.02/M
Extra fine	f_{gef}	0.02/M to 0.01/M
Super fine	f_{gsf}	0.01/M to ?/M
Lap finish	f_l	0.5/M to 0.005/M or less
Smooth	f_{ls}	0.5/M to 0.1/M
Fine	f_{lf}	0.1/M to 0.05/M
Very fine	f_{lvf}	0.05/M to 0.02/M
Extra fine	f_{lef}	0.02/M to 0.01/M
Super fine	f_{lsf}	0.01/M to ?/M
Polish finish	f_p	?/M9 to ?/M1
Buff finish	f_b	?/M9 to ?/M1
File finish	f_f	2/M to 0.2/M or less
Rough	f_{fr}	2/M to 1/M
Medium	f_{fm}	1/M to 0.5/M
Smooth	f_{fs}	0.5/M to 0.2/M
Very smooth	f_{fss}	0.2/M to 0.1/M
Stone finish	f_{st}	2/M to 0.1/M
Rough	f_{str}	2/M to 0.5/M
Smooth	f_{sts}	0.5/M to 0.1/M
Fine	f_{stf}	0.1/M to ?/M
Sand blast finish	f_{sb}	2/M to 0.2/M
Rough	f_{sbr}	2/M to 0.5/M
Smooth	f_{sbs}	0.5/M to 0.2/M
Mud blast finish	f_{mb}	0.2/M to 0.1/M
Ream finish	f_{re}	2/M to 0.2/M
Rough	f_{rr}	2/M to 0.5/M
Smooth	f_{rs}	0.5/M to 0.2/M
Cast finish	f_c	
Cast finish special	f_{cc}	
Forge finish drop	f_{fd}	
Forge finish hand	f_{fh}	
Drawn finish	f_{dr}	
Rolled finish	f_{ro}	
Commercial finish	f_{co}	
Scrape finish	f_{sc}	
Paint finish	f_{pt}	
Blue finish	f_{bl}	
Parkerize finish	f_{pr}	
Tin finish	f_t	
Galvanized finish	f_{gl}	
Copper plate finish	f_{cp}	

surfaces shall differ from drawing dimensions by a greater amount than the following:

Weight of Casting	Tolerances Allowed
Less than 100 lb	0.030 in.
100 to less than 500 lb	0.100 in.
500 to less than 5,000 lb	0.150 in.
5,000 to less than 15,000 lb	0.200 in.
15,000 to less than 25,000 lb	0.250 in.
25,000 lb. and above	0.300 in.

Special Castings—These castings shall be made under extra care with the use of match plates or otherwise to maintain uniformity of product, all parts of which will conform to the dimensions given on the drawing to within a plus or minus 0.020 in. tolerance. If a smaller tolerance is required for special castings than given above, the tolerance shall be specified with the dimensions concerned or in the block note for the piece so the information will come to the attention of the pattern maker.

Forge finish refers to the surface produced by the forging or drop forging operation, after such surface has been cleaned of scale and all fins have been removed.

Hand forgings less than 4 ft. long shall, unless otherwise specified, be allowed a total tolerance of 0.60 in. for diameters or thicknesses of 0.50 to 1.50 in. and 0.125 in. tolerance above 1.50 in. diameter or thickness.

Drop forgings shall, unless otherwise specified, be allowed a plus or minus 0.020 in. tolerance.

When the finish of surfaces of rolled, drawn, forged, cast or commercial material is covered elsewhere in specification for the material of the piece, finish for these surfaces may be omitted on the drawing.

The symbol *M*, which stands for thousandths, should be made by spreading the bars of the *M* so as to form angles of about 45 deg. at the top, as shown in the accompanying illustration. The number in the center designates in thousandths of an inch the distance between the crest and the trough of the waves of the surface and is measured in a line perpendicular to the plane of the surface. The number at the right of the *M* designates in tens of per cent the amount of bearing surface in relation to the whole surface.

It is understood that German machine tool manufacturers have adopted the letter *V* to designate fineness to finish, and also that the A.S.M.E. is tentatively considering this symbol for such usage. The question of whether the letter *V* or the letter *M*, as originally proposed by F. O. Hoagland, master mechanic of Pratt & Whitney, should be used was discussed with five leading engineers connected with drafting room work. Of the five consulted two were in favor of the *V*. It is believed that the letter *M* as described in the proposed instructions can be more easily recognized on a drawing. The letter *M* is often used to designate thousandths of an inch in measurement. However, if the letter *V* is considered more

satisfactory it would undoubtedly be more universal in its usage. Mr. Hoagland's idea of designating finishes, in multiples or decimal fractions of thousandths of an inch instead of classifying them in groups also seems to be an excellent one, for a grouping that might be satisfactory today might prove unsatisfactory in the future.

It is interesting to note that the various finishes in the proposed drafting room regulations have as far as possible been taken, as shown in Table II, from a geometric arrangement.

Advantages of a Standard

The advantages of a universal set of standard instructions on finishes for drafting rooms as proposed are:

1. The designing engineer has a specific method of designating the finish desired on the final product.
2. The draftsman, checkers or supervisors have a simple and easy method of showing the finish desired.
3. The manufacturers and men in the shops have definite but easily understood instructions on the drawing or print as to the finish desired.
4. Where finer finishes are desired and ordinarily expressed by the symbol *f* they may be exactly defined by the symbol *M* with numbers in the center and to the right.
5. Samples of finish need not be submitted with orders.
6. If samples for a shop or engineering room are desired, they may be made up without comparison with a standard sample.
7. Helpful in writing specifications.
8. When *M* symbols are used, there can be no misunderstanding as to quality of finish specified.
9. Universal understanding of finishes designated and required.
10. Ease in designating exact finish required will tend toward finer products, fewer failures and reduced costs of upkeep.
11. Prevent rejections because of misunderstandings as to quality of work ordered.
12. By using only part of the proposed system, designation of finish will be as simple as any in vogue at present.

Summarizing, if such proposed designations were universally adopted, the draftsman, checker, supervisor and designing engineer would have a practicable and simple method for designating surface finishes.

Bibliography

The following papers have been presented on this subject:

Appendix I of paper presented to A.S.M.E. "Microscopical Examination of Cross-Section of Surfaces," Dec. 1, 1930, by Dr. C. B. Sawyer, Cleveland, Ohio.

Paper presented to A.S.M.E. "A Survey of Surface Quality Standards and Tolerances Costs Based on 1929-1930 Precision Grinding Practice," Dec. 1, 1930, by R. E. W. Harrison of Cincinnati Milling Machine Company.

American Machinist. "Quality of Metal Surfaces," Nov. 23, 1932, by John Gaillard, American Standards Association.

Letter to Chairman Subcommittee on Finishes of A.S.M.E. "Measurement of Finishes and Designation of Same on Blueprints," Feb. 26, 1934, by F. O. Hoagland, Pratt & Whitney Company, Hartford.

Minutes of Meeting of Subcommittee No. 5 of A.S.M.E. on "Ways, Means and Apparatus for Measuring Quality of Surface," Dec. 6, 1934.

Minutes of Meeting of Subcommittee No. 1 on "Standardization of Surfaces Produced by Tools and Abrasives," Dec. 6, 1934.

Paper presented to S.A.E. "What Is Surface Finish and How Can It Be Measured and Specified?" Jan. 14, 1935, E. J. Abbott, University of Michigan.

Enlarged diagrams and designations of surface qualities based on depth of wave and percentage of bearing surface

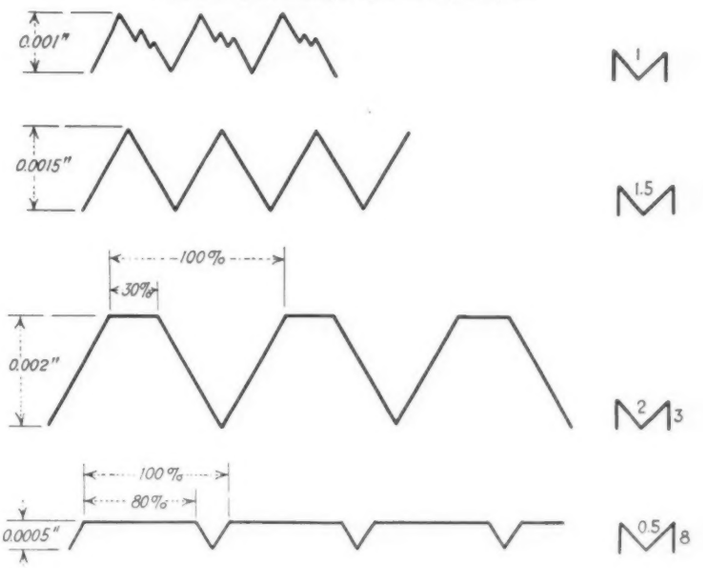


Table II—Proposed Surface Designations Based on Geometric Progression

Barked	$\frac{32}{M}$	Smooth	$\frac{0.5}{M}$
Very coarse	$\frac{16}{M}$	Very smooth	$\frac{0.2}{M}$
Coarse	$\frac{8}{M}$	Fine	$\frac{0.1}{M}$
Very rough	$\frac{4}{M}$	Very fine	$\frac{0.05}{M}$
Rough	$\frac{2}{M}$	Extra fine	$\frac{0.02}{M}$
Medium	$\frac{1}{M}$	Super fine	$\frac{0.01}{M}$
		Special	$\frac{0.005}{M}$

Characteristics of Anodized Aluminum

R. E. PETTIT
Aluminum Company of America

An explanation of the Alumilite process by which increased surface hardness, greater wear resistance, higher dielectric strength and desired coloring are obtained

WHEN in contact with moist air or oxygen, aluminum and its alloys become covered with an oxide coating. Because the oxide film is compact and continuous, this natural oxidation is not progressive. Although the natural coating is only infinitesimally thick, it serves as an impervious armor, shielding the metal beneath it from atmospheric attack. But by the Alumilite process, as described here, a similar coating is applied artificially over the coating that is formed naturally and a heavier and more durable armor is thus formed, as much as 0.001 in. thick.

Plain and colored finishes applied by the anodic process to aluminum keys, finger rings, bracelets, razors, pens, automobile handles and various cases

This artificial armor or oxide, preventing surface disintegration, is applied by electrolytic action. The first step in the process is the preparation of the work for the electrolytic treatment. If a high luster is desired, the work is polished. Dull or matte finishes may be obtained by sandblasting or scratch brushing. Buffing dirt and grease are removed by washing in solvents, such as carbon tetrachloride, or in alkaline solutions, depending upon the final finish desired.

After cleaning, the work is thoroughly rinsed in cold water, fastened to aluminum racks and immersed in a special solution of sulphuric acid at room temperature. In the electrolytic treatment, the work itself serves as the anode or positive terminal and the lead-lined electrolyte tank as the cathode. The process is often called the anodic oxidation process, because oxygen is, in effect, deposited on the surface and combines with the aluminum to form aluminum oxide. Once this oxide is formed, it does not dissolve by reversal of current.

Coating and Sealing

The bath is agitated by air or other suitable means, such as circulation of the electrolyte, to insure uniformity of bath temperature. The heat generated by the action of the electric current is removed by running cold water through lead pipes inside the tank or around the lead lining of the tank. The time normally consumed to produce a coating of sufficient thickness for good abrasion resistance and good weathering qualities is about 30 minutes. Because of the excellent "throwing power" of the solution, special cathodes are rarely necessary to direct the current into deep recesses.

After the work has been coated it is taken out of the electrolyte, still on the racks, and carefully washed in cold water. It is now ready for the sealing opera-

The anodic treatment is not limited to small articles. The Navy and Marine Memorial, Washington, D. C., the largest piece of aluminum statuary in the world, is Alumilited all over. It is 35 ft. high, 30 ft. long, 20 ft. wide and weighs more than 10,000 lb. The largest bird has a 6½ ft. wing spread

tion by which the porous surfaces are closed to prevent staining. The type of sealing solution depends upon the service to be performed by the coating. A generally useful sealing method consists of immersing the work in chemical solutions of a certain type. This solution impregnates the coating with materials which render it impervious and increase its resistance to corrosive influences.

After the work is unracked it is dried by exposing it to ordinary room temperature and allowing it to dry naturally; or it may be placed in an oven or on a steam table, tumbled in sawdust, or wiped. If the type of finish requires a polishing operation, the work is polished after drying.

Coloring the Metal

Much of the anodically-treated aluminum is unpigmented and takes its color from the natural appearance of the metal. But one of the unique features of the oxide coating is that it is adsorptive and can be colored with dyes or mineral pigments. In applying the color to the metal, the preliminary steps previously mentioned, including polishing, racking, cleaning and rinsing are identical. Treatment of the work in the electrolyte is also carried on similarly, but in some instances a more concentrated acid solution is required in order to obtain certain finish effects. Voltage, current density, and rinsing are the same.

Dyeing the oxide is accomplished through the adsorptive characteristics of the coating. While the processed material is still on the racks, it is immersed in a water solution containing a suitable dye. The average dyeing time is about ten minutes. While dyes are available which give a wide variety of brilliant colors and are readily adsorbed by the oxide coating, most of them eventually show fading on continued exposure to weather. The color penetrates through the coating giving deep, rich hues which have an underlying metallic sheen making them unusual and particularly attractive.

A greater degree of color permanence is obtained by the use of mineral pigments, although these pigments do not have the wider color range and intensity of dyes. However, experiments over a number of years have indicated that certain of these pigments are satisfactory for many exterior applications. The mineral pigments are produced by a two-step operation. Yellow, for example, may be obtained by first immersing the coated article in a solution containing a lead salt, a practically colorless compound. After a sufficient quantity of lead acetate has been adsorbed, the work is rinsed in water and then immersed in a solution of potassium dichromate, which has an orange tint. When the chromate solution comes in contact with the lead solution, a chemical action takes place producing an entirely new compound, known as lead chromate, which is yellow in color.

Aluminum automobile pistons are anodically treated to reduce rate of wear

When suitably colored, the oxide coating on aluminum gives a pleasing appearance to cocktail shakers, inlaid Micarta, automatic pencils, fountain pen parts, novelties, name plates, and other incidental pieces. The fabrication of name plates usually includes the application of two surface effects. These may consist of colored Alumilite finishes used in contrast with either plain aluminum or the uncolored Alumilite finish. In other instances, two colors may be used together giving greater permanence, better visibility and more pleasing appearance.

A two-tone effect may be applied to embossed surfaces by subjecting the background or the recesses to a sandblasting operation and polishing the raised areas or

highlights, after which the article is given the anodic treatment as previously described. The result is an article having a gray matte background. The depth of color depends upon sandblasting and the type of alloy used. After the work has been given its coat of color, it is rinsed in cold water and sealed. The work is then dried. If its luster is to be improved it may be buffed or waxed.

Alumilited work is not necessarily limited to small objects. An outstanding example of anodically-treated aluminum of large size is the Navy and Marine Memorial, Washington, D. C. This monument, depicting seven sea gulls hovering over a crested wave, was cast in a number of pieces. All of the pieces were given a coating by the Alumilite process in the largest tanks ever built for this operation. Color was added, the waves and the undersides of the gulls being colored in mottled green. The highlights on the wings of the gulls and on the foam of the breaking wave were colored in a tawny yellow to simulate sunlight falling on the group. This example of anodic coating will be watched with interest, for it is exposed to wind, sun and rain—a severe test for permanence.

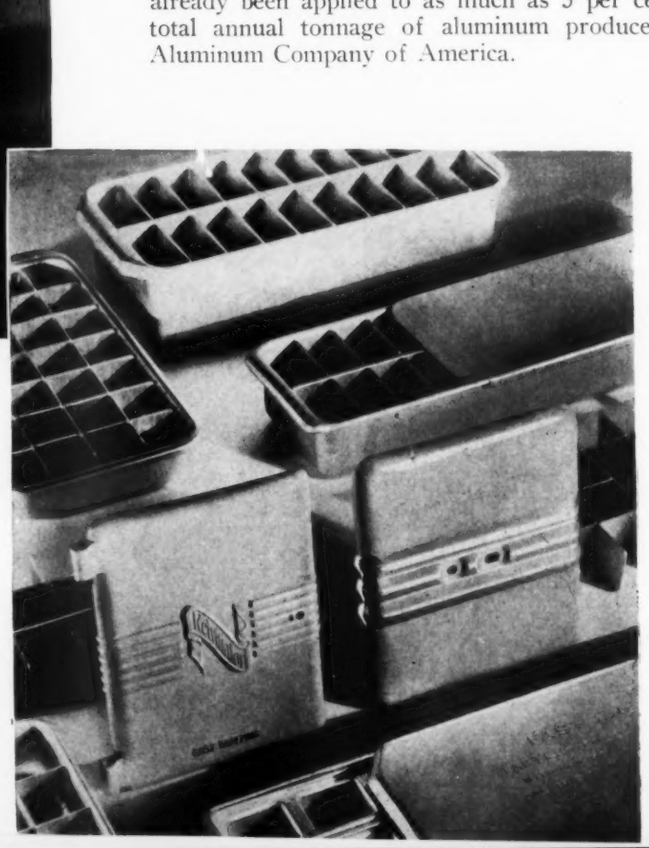
The central section of an all-aluminum grease gun, made of tubing, and colored a bright maroon by the Alumilite process

Aluminum automobile pistons, skin hardened by the Alumilite process, are tough and abrasion resistant with other important advantages. Other installations where anodically-treated aluminum has been used successfully for wear resistance are valves and gears on gasoline, oil and grease dispensing machinery, guides on blue-printing machines, garden implements, watch cases, and fishing tackle.

Through this process the surface of the metal is so hardened that smudging is prevented, which is one of the reasons for its use on such items as file guides, bus and street car stanchions and handrails, cafeteria trays, cooking utensils, showcase holdings, electrodes of permanent wave machines, and shoe eyelets. The process gives permanence to the finish on file guide tabs, store fronts, automobile radiator grilles, optical goods, and name plates; it hardens the surface of laundry mangles and die-cast hardware and prevents discoloration and staining. The finish will not chip or peel, even though the coated article is deformed by accident or intention. It cannot be flaked off, and within certain limits can be made flexible to take short draws and minor fabricating operations as in the manufacture of buttons, tags, small bottle caps, and embossed poultry leg bands. The film has a high dielectric property. When electrodes of permanent wave machines are coated with it they do not transmit electrical shocks to beauty salon patrons.

The cost of applying the anodic oxide coating to aluminum can be compared, roughly, to electro-plating. A plain coating may be compared with a buffed nickel plate job, while a color coating costs about the same as chromium plating over nickel, both operations necessitating two steps in the procedure. The cost naturally varies with the kind of work to be done, but countless numbers of novelties, such as automatic pencils, attest to the fact that it is not an expensive process.

It is not surprising that a surface treatment of such diversified qualities has found numerous applications. In many of the fields where aluminum is used, the anodic process is now considered indispensable. It has already been applied to as much as 5 per cent of the total annual tonnage of aluminum produced by the Aluminum Company of America.



Refrigerator ice cube trays, grids, covers and freezing compartment doors of aluminum, treated with the anodic process, have a hard, bright surface easy to keep clean

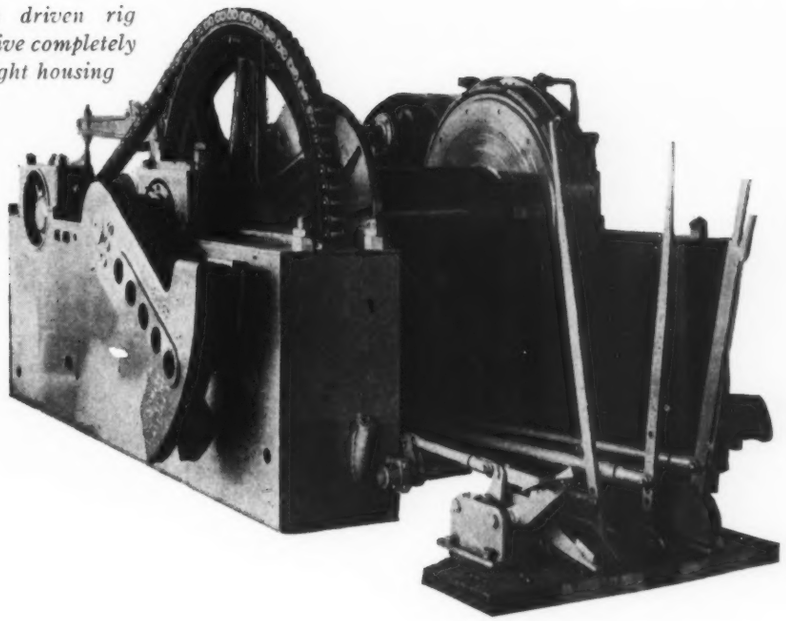


Fig. 17—Chain driven rig front with the drive completely inclosed in oil-tight housing

Designing Chain Drives—IV

Provisions that should be made for proper chain lubrication, the types of lubricants suitable for given conditions of operation and the methods of applying them, and dimensions to specify for oil-tight casings

G. G. MIZE and W. A. WARRICK
Chief Engineer *Mechanical Engineer*
Diamond Chain & Manufacturing Company

WELL LUBRICATED chains will last many times longer than those which receive inadequate or improper lubrication. Naturally, some drives justify a great deal more attention to lubrication than do others, but in every instance the designer of the machine should make adequate provisions so that correct lubrication can be applied easily.

Proper provision for good lubrication is reflected in the service value of the machine. With the chain drives well lubricated there will not be frequent interruptions for repairs and the adjustment of sprocket centers will be required only at long intervals. And because of longer chain and sprocket life the cost of replacements and loss of time in making them is greatly diminished. Good lubrication, the cost of which amounts to only a few cents per year, will ordinarily assure approximate equality of drive life and machine life. The satisfaction to the user of the machine is bound to be reflected in its prestige and market value.

The primary value in good lubrication is in preventing or minimizing metal to metal contact of pins and bushings. With the best lubrication that can readily be provided even a load sufficient to break the chain will not cause a rapid rate of wear. This has been tested, using red engine oil of Saybolt universal viscosity of 390 sec. at 84 deg. F. Even using oil having the least lubricating properties, the rate of chain elongation will be only slightly greater than that when red engine oil is used.

Long sprocket life goes hand in hand with long chain life. As long as the chain is elongated only slightly, the rollers will seat between the teeth instead of farther out on the teeth, as with an appreciably elongated chain. Seating between the teeth or close to the bottom diameter means that the amount of roller travel on the tooth face is less, hence wear is less. Good lubrication of the sprocket teeth contributes further to decreasing this wear. In sprockets for toothed chain, rollerless and block type chains wherein the links are subject to sliding meshing, this lubrication is still more important .

With poor lubrication or no lubrication, chain life may be so short as to be entirely unsatisfactory. Likewise, the sprockets will not last long because the chain with elongated pitch wears them rapidly. And in addition to all the other expenses and annoyances caused by rapid wear, drives that originally were quiet may become objectionably noisy.

Especially under heavy loads, improper lubrication results in metal to metal contact between the pins and bushings. Even though these are of alloy steel, case hardened and finely finished, and even though the rubbing speeds may be exceedingly low, the result is a roughening and galling of the bearing surfaces, tending to interlock them. Once the originally highly

finished surfaces have been impaired, deterioration will proceed at a faster rate.

At high loads and speeds, the temperatures developed may be sufficiently high to color the parts. Although high temperatures are not invariably the result of insufficient lubrication, at high speeds they are inevitable unless there is proper lubrication. Lack of lubrication is often made evident by the brownish or purplish color of the surfaces that have been in metal to metal contact, the high temperature having drawn the case hardened surfaces to such an extent that they can be cut quite readily. There is often a characteristic reddish brown oxide developed within the joints, which is often mistaken for rust and leads to the erroneous assumption that the chain was rusty when installed.

Lubricating merely the outside of the chain is not effective. Grease or oil on the outside of the chain does not indicate that the bearing surfaces between the pins and bushings are being lubricated. Inspection might show the joints to be bone dry and full of the powdery brownish iron oxide caused by the absence of lubrication and a resulting high temperature. It should not be concluded that chain drives tend to run hot. The average chain drive operates practically at room temperature.

Lubrication might be neglected with apparent impunity when drives are considerably over-chained, or when they are in intermittent service. Similarly, slow speed chain drives are less injured by neglect of lubrication because wear naturally proceeds at a slower rate, and therefore there is not such a tendency toward overheating. With poor lubrication, especially at high speeds, longer chain and sprocket life will be possible if shorter pitch multiple chains are selected.

For both high and low-speed drives, the best general-purpose lubricant is oil of good quality and of relatively thin body. For small chains operating at normal temperature, S.A.E. No. 20 and No. 30 viscosity oil are best. For heavy chains that have larger clearances S.A.E. No. 40 oil should be used. For low or high temperatures, the oil selected should have a viscosity at the operating temperature equal to that of the oil that would be selected for operating at normal temperature.

Greases or heavy oils applied cold to a cold chain contribute nothing to its lubrication. To be effective the lubricant must enter into the chain clearances, especially in the pin-bushing bearings. There are many commercial greases and heavy oils that are excellent lubricants for chain, but only when they are melted thin and the chain submerged in them, being allowed to remain long enough for equality of temperature to be established between the chain and the hot lubricant. Working the chain joints will help to impregnate all clearances of the chain with the lubricant. After the chain is removed from the bath, it should be allowed to drain and cool with the links pushed together. Excess lubricant should then be wiped off.

Care must be taken in heating grease or heavy oil. It should be heated just enough to be relatively thin. If the temperature is allowed to go much higher than 200 deg. F., the hardness of the carburized parts will be impaired.

Some greases will leave a residue and the same is true of oil. If the residue clogs the clearances, it will prevent ready access of lubricants subsequently applied. This should be avoided by cleaning the chain thoroughly by immersion and scrubbing in kerosene. This opens the oil channels.

If the chain drive is on a machine that is washed down periodically, as in dairy or ice cream plant equipment, protection from splash should be provided, if practicable. If this cannot be done it should be specified that the chain should be lubricated periodically, every month or two, by immersion in hot cylinder oil, not dewaxed. Such steam engine cylinder oil is tenacious and will withstand washing action better than any other lubricant with which the writers are acquainted. It has been proved by numerous tests to be far superior to the average cup grease or axle grease.

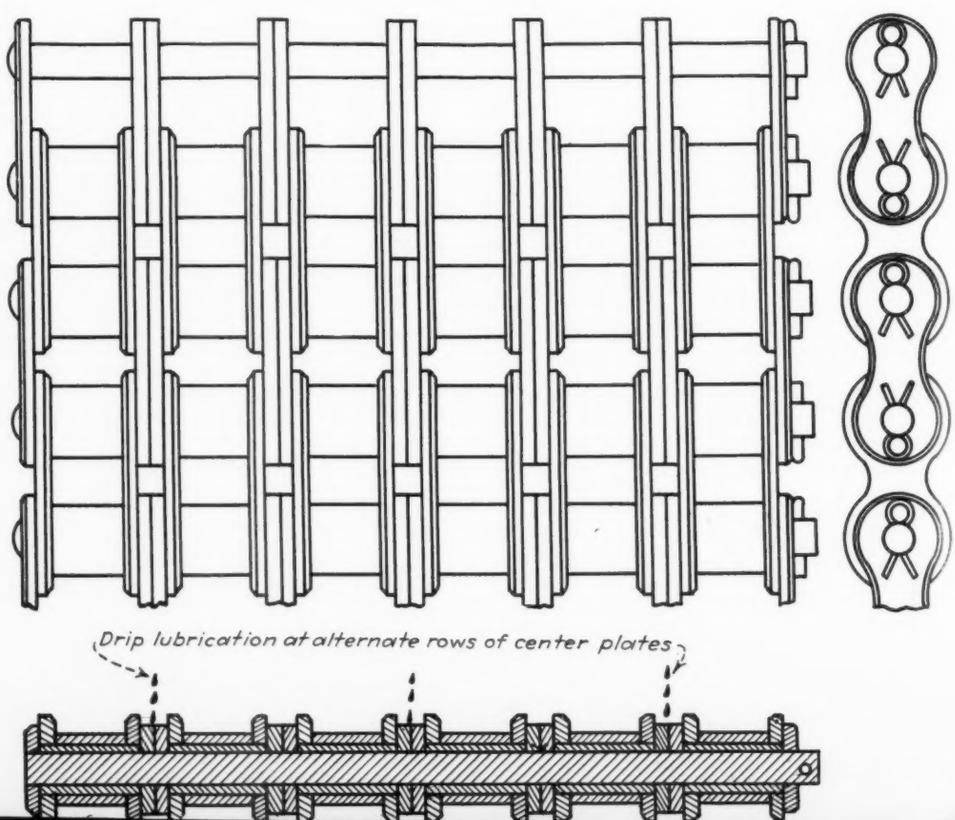


Fig. 18—The oil drip must be in the plane between the roller link plates and the pin link plates. Multiple chains should have a drip for each alternate row of center plates

Waterproof greases such as used for water pumps on automotive engines would probably be equally good, although the writers have not investigated their properties.

For high temperatures, as in oven work, special high-temperature lubricants might be of some value, assuming that such lubricants can penetrate the small clearances of the chain and will not leave a residue. But it is generally considered better to use powdered graphite, or else to use powdered graphite in a light oil that will serve as a vehicle and will evaporate without leaving a residue.

There are three general classifications of lubrication methods for chain drives, *i.e.,* manual or periodic with oil can or brush; drip or wiper lubrication; and copious lubrication, which implies running the chain in a bath or the provision of a generous flow by means of a small auxiliary pump.

Manual lubrication is ordinarily adequate for slow speed drives not subjected to particularly heavy loads. Grease lubrication at more infrequent periods would provide about equally good results. Periodic immersion in grease melted thin is ordinarily too much trouble to be considered practical except under unusual circumstances.

Periodic lubrication may be adequate for high-speed drives, possibly those in which the speed of the faster running sprocket is 900 to 1,800 r.p.m., but only if service is intermittent and if the drive is lubricated quite frequently. Manual lubrication is not recommended for high-speed drives, except when limited hours of running would make it uneconomical to invest in a better lubrication system. Similarly, there are many small drives which get no lubrication simply because the replacement of the chain is so inexpensive.

For drives that are manually lubricated, for safety preferably with a brush or long spouted can, an inclosure or guard is necessary only where the oil is thrown off. There is little tendency for the oil to throw other than in the trace of the chain. The guard is frequently of wood, or else of sheet metal, possibly 2 or 3 in. wider than the chain, and may be flanged inward an inch or so to prevent oil creeping around the edges.

Drip lubricators do not necessarily require a tight inclosure if a little throwing or leakage of the oil is not objectionable because of creating a slipping hazard or a fire hazard. Drip lubrication requires little oil, although much more than capillary lubrication. Plain cups, sight feed cups or conventional lubricators with

Fig. 20—Method of mounting a commercial oil seal in a chain casing. Such oil retainers represent a small additional cost but have been found extremely effective

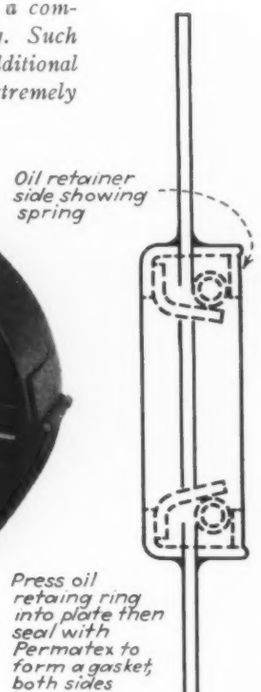
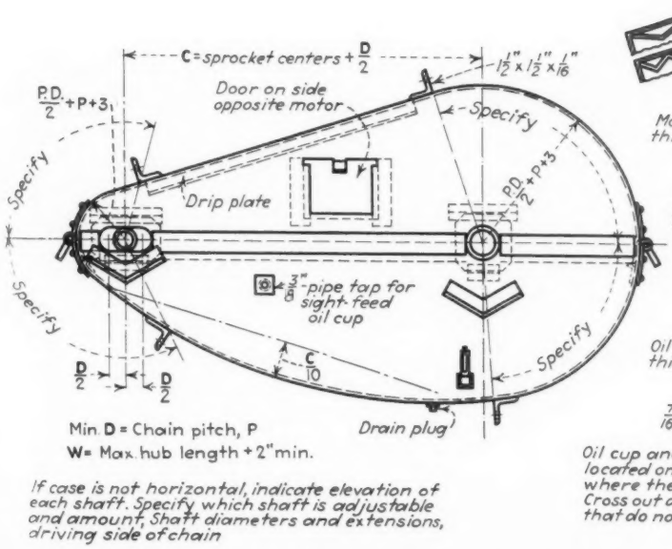


Fig. 19—Oil tight casing fitted with a drip lubricator. For bath lubrication such casings are fitted with a combination oil-level indicator and overflow to provide a tell-tale against too high an oil level


C = sprocket centers + D/2
1½" x 1½" x 1/16"
P.D./2 + P + 3
Door on side opposite motor
Specify
Drip plate
P.D./2 + P + 3
Specify
Specify
Specify
3/8" pipe tap for sight-feed oil cup
D/2
D/2
C/10
Drain plug
Min. D = Chain pitch, P
W = Max. hub length + 2" min.
If case is not horizontal, indicate elevation of each shaft. Specify which shaft is adjustable and amount. Shaft diameters and extensions, driving side of chain

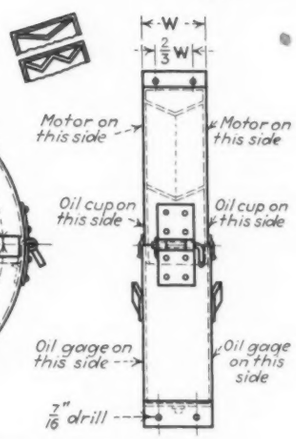

W
2/3 W
Motor on this side
Motor on this side
Oil cup on this side
Oil cup on this side
Oil gage on this side
Oil gage on this side
7/16" drill
Oil cup and gage preferably located on side opposite motor where they can be seen easily. Cross out above notations that do not apply

Fig. 21—Dimensions that must be specified when ordering chain drive casings from the manufacturer. Generous clearances between the drive and casing should be allowed, if possible. An extra inch or two in the size of the casing adds but little to its cost

a number of leads may be employed, depending on the character of installation desired. The oil leads should not be kinked closed and they should be firmly anchored so that they will not vibrate loose. The actual point of oil delivery should be checked to make sure that the oil will not be wasted by missing its proper target. Oil cups should be accessible and visible, but they should be protected.

Probably more than 95 per cent of all chain drive installations are oil lubricated. The point of application of the oil is of considerable importance. The oil should be applied to the upper edges of the side plates in the lower run of the chain at a point just before where the chain meshes with the sprocket. At this point the chain joints are relaxed and there is also a natural tendency for the oil to centrifuge through the chain as it goes around the sprocket. This increases the chances of oil reaching the pin-bushing bearing and the oil that is thrown off the chain provides a certain cleaning or flushing effect.

For a single strand chain, the oil should drip on the side plates from whence it will spread along the length of the pin and the bushing. An oil drip to both sides of a single strand chain is not needed, even for large chains. But it is important that the oil drip be in the plane between the roller link plates and the pin link plates so that it can reach the pin-bushing bearings. Oil applied directly to the rollers cannot possibly reach the pin-bushing bearings, because the bushings and the roller link plates are a press fit. Oil thus applied is wasted in so far as lubrication of the pins and bushings is concerned.

A single drip will ordinarily properly lubricate double strand chain if the drip is applied to the edges of the center plates. Similarly, a single drip will lubricate triple strand chain fairly well if applied to either row of center plates, but the chains will eventually wear a little one-sided, developing more pitch elongation on the side which receives less lubricant. A double drip is better for triple strand chain. Quadruple, sextuple and octuple strand chains, if drip lubricated, should have a drip for each alternate row of center plates, each drip lubricating two strands.

Drip lubrication with an open drain in the bottom of the inclosure so that oil will not collect is recommended for drives in humid atmospheres or where the machines are cleaned with a hose, as in dairies, ice cream plants and creameries. For such applications bath lubrication is inadvisable, even though an overflow be provided. Without a drain condensation naturally accumulates under the oil and the chain soon becomes lubricated with a mixture of water and oil. This will not affect the external appearance of the chain, but deep pitting, galling and discoloration are immediately evident when it is disassembled and the bearing surfaces are inspected.

With drip lubrication and also when the chain runs in a shallow bath of oil, a mist of oil is created within the casing, unless the chain speed is quite low. This mist condenses on the shaft and if not restrained will travel along it. Creeping of oil may be restrained by felt washers in pockets inside or outside of the case. Oil resistant sheet packing, closely fitting the shaft and with metal backing, mounted slidably for adjustment or for convenience, sometimes gives quite good results. But with high-speed shafts the seal must be accurately positioned to avoid cutting the shaft in spite of the lubrication.

Various commercial leather seals have been found to be excellent. An example of one of these is shown in Fig. 20, which also indicates the manner of mounting. Such oil retainers are relatively inexpensive, but are effective.

With bath or pump lubrication, an important advantage is that these methods, in conjunction with oil retaining inclosures, will avoid trouble such as would be caused by neglecting to fill oil cups or to lubricate with an oil can.

Deep submergence of the chain in bath lubrication may cause a 40 deg. or more rise in temperature created by the friction of the chain running through the oil. At the lowest point of the chain it should not be submerged more than to the height of the side plate. Oil levels should of course be checked at reasonably frequent intervals, until the oil tightness of the particular inclosure has been well established.

Oil slingers sometimes provide a convenient means for the lubrication of inclosed drives, the slinger or disk just dipping into the oil and throwing it on to a baffle plate or something of that sort which will conduct the oil to the chain. Oil disks should be firmly fastened to the shaft. Slingers, which have somewhat the general appearance of clock hands are usually made of spring steel, free to pivot on a hardened shouldered cap screw which is tapped into one or both ends of the hub of the lower sprocket. Slingers and disks are of greatest value when the oil level must be appreciably below the drive itself.

In designing oil retaining inclosures for roller chain drives, the casing manufacturer must have the information as indicated on the accompanying Fig. 21. Special care should be taken to indicate properly the location of the openings and to give all of the data as indicated in the figure.

As chains gradually wear, they will ride a little farther out on the sprocket and allowance must be made for this. In general, it is wise to allow generous radial and axial clearances between the drive and the casing, because with small clearances there will be windage pressures and currents set up which can create serious problems in preventing leakage of the oil past the oil seals around the shafts.

Oil levels indicators are particularly desirable in order to prevent overheating from too high an oil level. An overflow feature is usually combined with the oil level indicator, providing a telltale against too high an oil level.

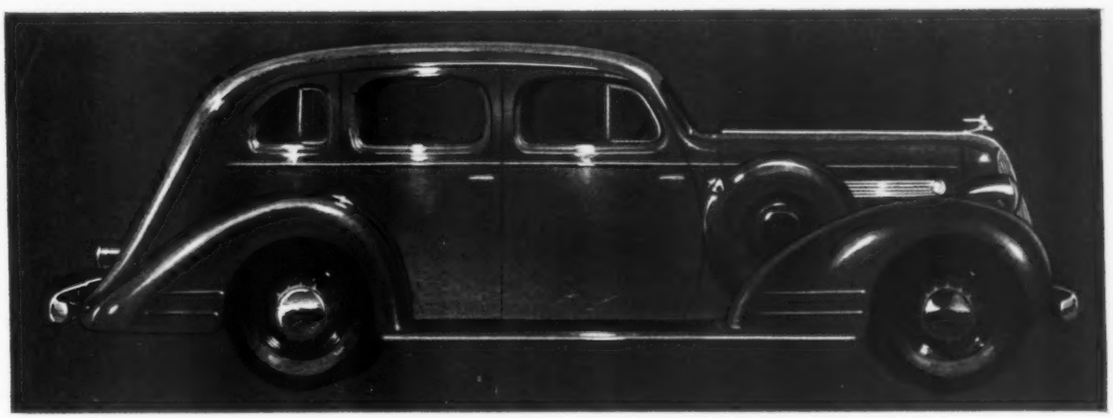
With pump lubrication, it is usual to employ a spring loaded relief valve and a cock or valve for regulating the amount of flow. An exceedingly small pump is capable of supplying ample lubrication for even the largest drive. It is inadvisable to use strainers if the casing is oil tight. These would then be unnecessary and if the strainers clogged it might not be noticed for a long time that the chain was not receiving oil. Drain plugs are a great convenience for emptying the case and flushing it prior to renewal of the oil.

If clearances are generous, venting of cases is rarely necessary, but with small clearances, high chain speeds and the chain running through the oil, vent pipes will frequently permit the drive to run a great deal cooler than without venting.

Getting the Right Color

HOWARD KETCHAM
Color Engineer

Color designation in terms of Munsell hue, value and chroma, and how consumer color preferences, disclosed by analyses of market surveys, eliminates wasteful color duplication and stimulates sales, as exemplified in the automobile industry



Pontiac Eight with body color to harmonize with its taupe mohair or tan broadcloth upholstery

A SURVEY conducted in the motor car industry brought to light three significant facts: (1) About the year 1909 car sales could be enhanced through national advertising. It worked. (2) Up until 1910, cash sales were the universal rule. Around 1914, it was discovered that sales could be encouraged by installment selling. (3) Shortly after 1920 color appeal was found to influence sales, and by 1929 every automobile builder had in his service a color engineer.

Surveys subsequently conducted by the *Automobile Color Index* revealed surprising local color preferences. It has been verified time and again that motor cars that are smart and attractive looking sell easier and command more advantageous prices than do those about which it can merely be said that "they perform satisfactorily" or that "they are low in price." Consequently, in automobile merchandising correct color choice has become a most important factor. Until recently car builders relied principally upon costly design changes in order to insure individuality and distinction. Now, color is employed as the chief practical means to escape standardization easily and at low cost. This is also applicable to all other fields of product design wherein quantity production is involved.

Color guidance that produces results by arresting the eye through sheer merit of hue is excellent sales insurance. It guards against undue loss from ineffectual color selections. Repellent looking merchandise escapes the eye or else is ignored by the modern consumer.

Familiarity with color markets is becoming a necessary factor if ready acceptance of production color releases to the seven geographic car sales zones in this country is to be assured. Up to now, for the most part, all territories have been treated practically alike with respect to the car colors they have been expected to absorb. But, in addition to fashion undercurrents that sweep the country in successive fad-waves, there is a specific local color reaction in each section of the land.

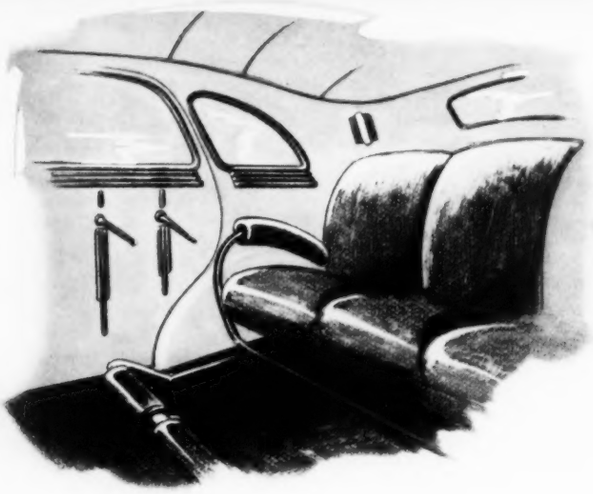
A few car colors properly selected in keeping with consumer likes do more to establish ready acceptance than can be had by turning a prospect loose before a veritable ocean of color and expecting him to buy.

Color analysis for style markets should enhance three fields of acceptance:

1. The metropolitan trend, which is built upon acceptance derived from the latest influence of stylists and publications.

2. The middle acceptance, to which belong those people who are afraid to try the new colors as being too daring. These people can generally be "sold" if faced with adequate sales ammunition.

3. The tastes of the country as a whole. To this field belong those people who hesitate a long time before accepting new colors and who will continue to demand the



Upholstery and appointments must harmonize in color, as in this rendering by Alexis de Sakhnoffsky, colored by Howard Ketcham. The hardware is Alumilited

old staple colors. These people cannot be sold anything new. Their preferences change slowly and with the times.

In analyzing color trends it is imperative to keep the style markets in mind. What is getting out of date in one group or in one part of the country may be coming into increasing use in another section of the country. This is one of the basic reasons why color surveys should be made constantly in the automotive and all other industries, covering all parts of the country and all groups of people. Surveys such as those conducted by the *Industrial Color Index* reveal the definite color trends that exist in all color markets.

If blue happens to be one of the popular hues, the particular color of blue is important. This can be determined in terms of hue, value and chroma attributes, as defined by Albert H. Munsell. These Munsell color attributes are defined as follows:

Hue is that attribute of a color by virtue of which the normal eye perceives it as differing from white, black and neutral grays. Value or saturation is that attribute of a color by virtue of which the normal eye perceives it as holding a position in a light-to-dark scale. A light value is sometimes called a tint and a dark value is sometimes called a shade. Duco colors extend from dark to light in 12 visually calibrated sequences. The lowest or darkest value has a notation of 000, then come values of 00, 1, 2, 3, etc., up to 10, which is the lightest value.

Chroma, or purity, is that attribute of a color by virtue of which the normal eye perceives, in addition to hue, the presence or absence of gray. An olive green is a color of weak chroma, while an emerald green is described as having a strong or powerful chroma. All calibrated automotive colors are now available in variations that extend from neutral gray or black to the maximum chroma or purity strength that pigments permit, at each level of value in all durable hues. Value levels in Duco colors are indicated by a numeral set above a line at the right, as green 2/. In designating the chroma strength of a color, the chroma numeral is placed below the line under the numeral of value. Thus, we have R4/9 for red at 4 value and 9 chroma.

Red, yellow, green, blue and purple are the principle hues employed in the recent standardization of automotive colors. If we were to take a circular disk, say 4½ in. in diameter and divide it into five equal surface areas with each area representing one of these principal hues of equal value and chroma, upon spinning the disk the colors would resolve into a neutral gray. This gray would be light or dark, dependent entirely upon the value of the principal colors used. Yellow-red, green-yellow, blue-green, purple-blue and red-purple are known as the intermediate colors of the system. The secondary intermediates are comprised of red-yellow-red, yellow-red-yellow, yellow-green-yellow, green-yellow-green, green-blue-green, blue-green-blue, blue-purple-blue, purple-blue-purple, purple-red-purple and red-purple-red.

Of course there are upwards of one hundred color families or hues distinguishable to the unaided eye. One hundred distinguishable hue variations can be made in automotive lacquers. Eighty of these variations would be so similar to their neighbors in appearance that twenty hues appear to allow sufficient range between color families so that each hue is definitely distinguishable. For example, all calibrated colors include all full strength hue variations at each step of value that can be represented in terms of chroma. There are no chroma steps at the eighth and ninth steps of value because chroma cannot be developed in lacquer at these two top values. For each of the twelve steps of value, when possible, there is a complete range of chroma steppings in each durable hue.

Each value and chroma variation has been calibrated orderly and equally, so that in each durable hue in a

Typical Automobile Parts

Plaskon—by Toledo Synthetic Products, Inc.

range of about 600 calibrated key colors it is possible to represent the vast unorganized mass of 13,000 automobile colors that once were used, many of them undistinguishable from one another.

Color reactions are never general; they are specific. If a market analysis for color appeal is to have any value, it must produce specific results. Only by knowing definitely the particular colors to which the public is most susceptible, smaller inventories, confined to the most salable colors, can be maintained. By no other way can production be efficiently geared with what the public is buying and with what it will buy next month or next year.

With reference to the colors that have fashion merit and their application to the body lines of a particular make of car, everything depends on the good taste of the color engineer responsible for its execution. The skill with which he adapts color arrangements to utilitarian requirement determines, to a large extent, the degree of excellence by which the appearance of one make of car can excel another, regardless of how closely the rules of harmony have been observed. Automobile color layout work requires special consideration and experience, because an automobile body provides no perspective.

Made From Colored Plastics

Tenite—by Tennessee Eastman Corporation

In 1926 automobiles were finished in as many as eight separate colors on one car. Upper and lower body, belt, window reveals, mouldings, stripes, fenders and wheel areas were finished in strongly accented hues that vastly nullified all possibilities for an appearance of unity in surface composition. Central design themes were thus destroyed. There was seldom any relationship between the colors used. Common factors of hue, value and chroma of regular progression of color change were not then understood by car builders or else were ignored. Many more car models were offered in those days than now. Most builders changed the colors on all models every ninety days.

Today most cars are finished entirely in one all-over color. Some have secondary accent colors on stripe or wheel areas. This allows for greater beauty of design by bolstering unity of composition into one central theme. Overgrayed or "muddy" looking colors are no longer used. The advent of calibrated colors has fostered a greater comprehension of proper color relationships and expedited their use as such in complementing streamline design requirements.

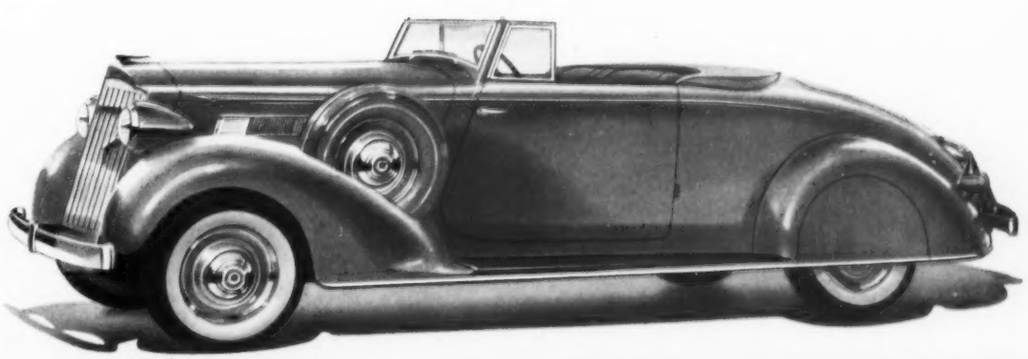
Automobile showmanship has also undergone marked advances in keeping with the advances of a more sophisticated market. Everywhere there are instances of a more thorough understanding of the basic facts and principles underlying all color problems.

There was a time when cars regardless of color were shown against any colored background. This was, in most instances, the color of the back wall of the showroom. If the wall happened to be yellow and the car purple-blue, all was well and good. But in many instances yellow cars against yellow backgrounds or green cars before green walls, nullified display contrast.

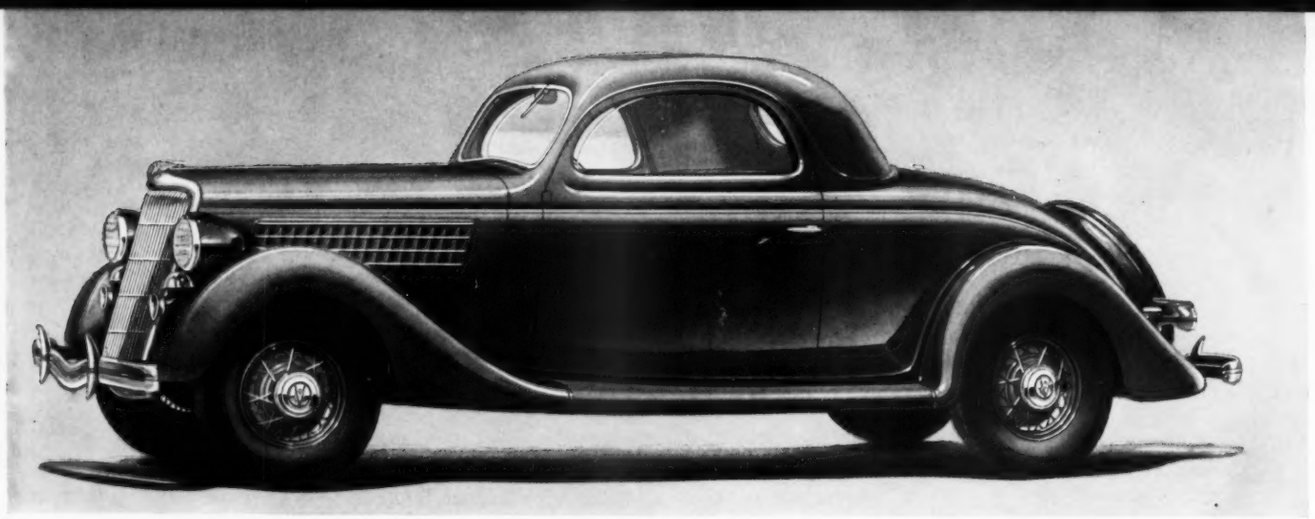
The moment backgrounds are changed or two colors are placed together, they become subject to surprising changes in any one or more of the characteristics of color. This is because any two adjacent colors produce simultaneous contrast effects in each other. These modifications by simultaneous contrast indicate why we should be familiar with the effects produced on color by backgrounds and surroundings. We need to know what colors to expect when combining colors in order to know what to avoid as well as what to use. We cannot escape the influence of color; everything in life has its own distinctive color.

When more than one color is put in an arrangement, an effect of design is produced. It is the knowledge of the broad principles of color relationships that is making the advent of the color engineer helpful in modern merchandising.

Those who would perfect themselves in the art of color can do no better than to gain a familiar acquaintance with the splendid color decorations found in Byzantine or Persian illuminated manuscripts, Oriental rugs, Chinese patterns on Ming jars or cloisonne vases, the gorgeous color decoration of the Ravenna mosaics,



Packard 120, finished in green, a color that was fourth choice last year and is now third choice



Ford three-window deluxe coupe, finished in gray, a color that is becoming highly popular. Instrument panel, steering wheel and moldings are taupe to match upholstery

the Gobelin tapestries and the porcelain of Sevres. The Paris modistes, expert at successfully selling styles for the whole world to follow, appreciate and use these inspirations constantly.

At the present time car builders are shipping car colors as follows:

Black	36.48 per cent	Brown	12.31 per cent
Blue	13.20 per cent	Maroon	3.59 per cent
Green	12.76 per cent	Gray	1.74 per cent

Last year at this time the factories were releasing colors in the following order:

Black	32.88 per cent	Green	11.91 per cent
Blue	19.39 per cent	Brown	11.34 per cent
Gray	15.30 per cent	Maroon	9.18 per cent

From this it appears that black has ascended still farther in consumer color acceptance. Blue, gray and maroon have greatly declined. Green and brown have advanced somewhat.

Undoubtedly, part of black's appeal is based on its tendency to create an appearance of solidarity and heavy mass in the lines of an automobile.

Among the new colors being promoted for fall and winter are clean blues of greenish hue taken from the sky where it appears bluest, golden yellow, reddish browns and gray. The market is searching for better looking greens and reds. There is a noticeable interest manifest in gray in all its variations. It is not easy to predict how long this trend will survive. Its present popularity is based on the fact that it is the first time it has been featured in many a year. Because of the degree to which gray is being promoted it is probable that it will become too popular at a relatively early date and then die quickly.

Latest automobile color style note—a rendering by Alexis de Sakhnoffsky. Windshield, instrument panel, steering wheel, control buttons, dials in Alumilite green. Colored by Ketcham

Besides the old familiar standby, slate gray, there is a new gray called Mushroom. This is decidedly warm in hue and is being introduced in the motor car industry for the first time this fall. Another gray of rising style appeal is Stiletto, this is a sleek nuance that is decidedly appropriate for the smoother new designs.

Gray happens to be the most versatile of colors; it combines smartly with everything. With gray any desired effect can be achieved. With pastel stripe and wheels, gray can be made to look meek and subdued. With red, gray becomes sporting and debonair. With cerise, it looks sophisticated, and with brown, gray looks suave. A smart and new accent note of distinction for the gray car is a striping combination of cinnamon brown flanked with yellow. On the popular disk type of wheel, yellow with a wide central band of cinnamon would look well. Other excellent accent colors for use with gray during the coming season include: brick, light bright blue and coral.

Car interiors, if they conform to the decorative trends, will be dark, with clear strong colors. There is a distinct note of elegance in interiors planned for this fall. This calls for vividness of detail and makes room for refinement of detail such as aluminum hardware colored by the Alumilite process to tie in with some attractive element of the exterior color scheme and complete the ensemble. Leather and fabrikoid interiors and accessories are also coming into fashion. Better qualities of material that will take pastel and gay colors with equal effectiveness, are being demanded.

The need for constant vigilance toward market acceptance of color is obvious. When certain colors have reached the last plane of their style life it would be disastrous to contemplate using those same colors immediately for new cars designed for sale in the "prestige" field.

The automobile manufacturer who takes time to test his market to uncover consumer color preference and who meets the requirements disclosed by his market analysis with skill and good taste, can do much at little cost to strengthen his sales position. Calibrated colors afford every advantage in operating economies by eliminating wasteful color duplication. Calibrated colors stimulate sales through the greater color range, individuality, newness and harmony their use affords.

Motions in Four-Bar Linkages

JOHN A. BRADSHAW
Providence, R. I.

How the four-bar linkage can be substituted for cam mechanisms to obtain quick return, dwell, straight line and other motions, as determined by using an adjustable celluloid model that traces point paths

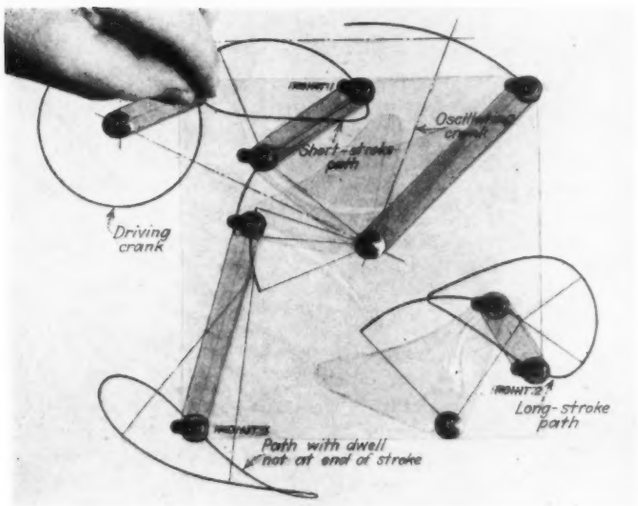
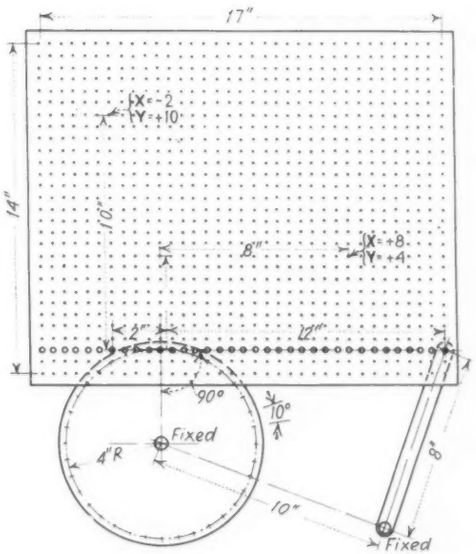


Fig. 1—Three types of dwell motions demonstrated in a working model of the four-bar linkage. Fig. 2—A celluloid model for determining available linkage motions



THERE are a number of advantages in using four-bar linkages in place of cams. Because the linkage usually has lower inertia and lower rubbing velocities at the bearings than the equivalent cam and follower mechanisms, higher speeds of operation are possible. Pin joints in linkages are plain bearings making contact over finite surfaces whereas the cam and follower have only one point or line contact. To avoid abrupt changes in cam profile the base diameter of the cam must be large, resulting in high rubbing velocities that make good lubrication difficult. High forces from return springs and impact stresses that may result in fatigue failure in cams are not present in linkages.

A variety of motions can be obtained from points in the bar connecting the two cranks in four-bar linkages. With one end of the connecting bar guided in a complete circle and the other end following the arc of a circle, the intermediate points will have a motion that is a combination of the two. As shown in Fig. 1, still different motions are possessed by points that are not on the centerline of the bar.

For the path of any point in the connecting link a mathematical relation can be derived, but this expression is a sixth degree equation containing nine parameters. For an ordinary linkage arrangement, the substitution of link lengths in this relation results in an expression with as many as 46 terms having combinations of variables to the sixth and descending powers. An analytical treatment therefore is of little value. However, the path of any point in the connecting link can be obtained from a mechanical model, such as the one shown in Fig. 2, constructed of transparent celluloid. By rotating the crank the paths of various points can be plotted. A large sheet of celluloid with small holes spaced on half-inch squares is used for the connecting link. A row of larger holes near the bottom of the celluloid sheet permits separation of the cranks to distances up to 17 in. at half-inch intervals.

For designating the motions of the linkage, the left-hand crank is considered as the rotating crank, the zero-degree position being vertical. The right-hand crank is the oscillating crank, and is located so that the connecting link center line is at right angles to the left-hand crank in the zero position. With this designation the location of any point in the field can be readily described. The center line of the left-hand crank becomes the y-axis, the center line of the connecting link becomes the x-axis, the pin joint between the two members being the origin of coordinate axes. A point 4 in.

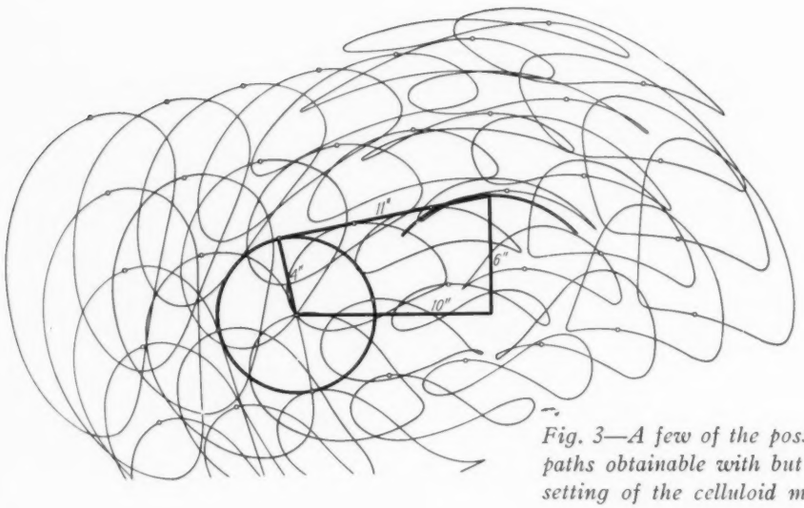
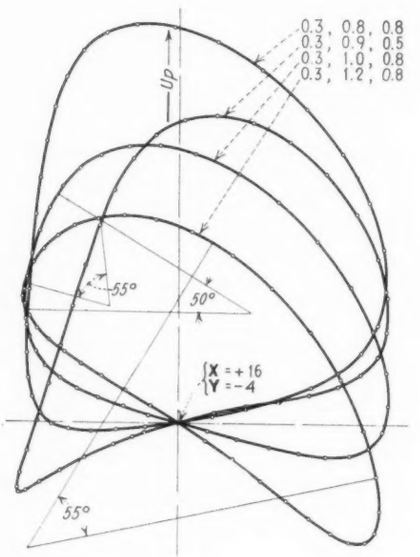


Fig. 3—A few of the possible paths obtainable with but one setting of the celluloid model

Fig. 4—Point paths with different combinations of link lengths. Circled points indicate positions at 10 deg. intervals of the driving crank



above the center line of the connecting link, and 8 in. to the right of the center line of the left-hand crank has the coordinates $(x = +4)$ $(y = +8)$. By inverting the connecting link so that the center line is at the top of the sheet negative values of y may be treated. With the model mounted over a sheet of paper on a drafting board, a pencil in any hole in the rectangular connecting link draws the curved path of the point when the left-hand crank is rotated. Fig. 3 shows a number of these paths for only one setting of the celluloid model.

For convenience the lengths of the other links are given in relation to the base link, which is 10 in. long. The ratio of the left-hand crank is given first, the connecting link second, and the right-hand crank ratio last. Thus, (0.4, 1.1, 0.6) denotes the linkage shown in Fig. 3, wherein the left-hand or rotating crank has a 4 in. radius, the connecting link is 11 in. long, and the right-hand or oscillating crank has a 6-in. radius.

In studying these paths the effect of different link lengths is found by drawing the path of one point with one set of link lengths, and changing the crank centers so that the connecting link always starts from the same zero-degree position. Thus, the coordinate axes of the point are the same, and successive paths always pass through the same zero position.

By marking points on the paths to indicate 10-degree intervals of the rotating crank, the points are spaced on a time basis if the crank rotates at a uniform speed. The diagram, Fig. 4, shows a few characteristic paths obtainable. The coordinates at the zero position denote the location of the point that traces the path. Other paths of the same point are shown with different ratios for the lengths of the links. Sustained circular arcs are indicated with witness lines, with the included angles denoting the driving crank angle corresponding to the length of the circular arc path.

For example, the curve (0.3, 1.2, 0.8) in Fig. 4 has a circular portion of the curve corresponding to a 55-deg. rotation of the driving crank. The point where the curve departs from a circular arc cannot be determined with precision since it is a matter of individual judgment as to where the path becomes tangent to the circular arc. However, a circular arc drawn through the center of curvature will coincide with the curve over an appreciable length. Thus, the describing point traverses a portion of its path in such a manner that it always keeps at a fixed distance from some external point.

For paths with portions closely approximating a circular arc, an additional link as long as the radius of the circular arc can be pinned at one end to the center of curvature of the arc. This additional link will have no tendency to displace the center of curvature while the describing point traverses the circular arc. A push rod connected to the radius link at the center of the circular arc will remain motionless as long as the radius link moves on the circular arc. But, when the crank motion advances the point beyond the circular arc, the radius link will displace the push rod. Thus, a period of dwell can be introduced into the motion of the push rod, as shown in Fig. 5. With the linkage in its zero position the push rod takes the form of a rocker conveniently pivoted on the shaft of the oscillating crank. The circular arc for the point on the horizontal link is nearly 120 degrees of the driving crank cycle. During this interval the rocker dwells.

Periods of dwell come at the end of the rocker motion, since at the ends of the arc the path curves in towards the center of curvature. However, the circular arc is not always tangent to the path. At one end of the arc the path may curve in toward the center of curvature of the arc and outward away from the center at the other end. Such a circular arc does not contain points of the path that are farthest from the center of curvature, and the dwell period is not at the end of the rocker motion. Fig. 6 illustrates this type of linkage.

Another type of path, shown in Fig. 7, contains a straight line portion of appreciable length. The motion obtained from this path could be used as a scoop or could provide a stirring motion.

Paths can also be obtained with substantial lengths that closely resemble a quarter moon. If the radius link is about the same length as the radius of curvature of both branches of the curve, a period of dwell is obtained at both ends of the stroke. In paths fashioned like a figure 8, a radius link, approximately the length of the radius of both circular curved branches on the same side of the long axis of the figure, moves a follower with two strokes and two dwell periods to each revolution of the driving crank. In nearly all paths, one branch of the path is traversed more rapidly than the other, giving a quick return motion in combination with a long or short stroke.

In the linkages shown in Figs. 5, 6 and 7 the point path is short in the direction that the radius link is displaced, giving the rocker only a small displacement. Point paths resembling a tear drop or candle flame, as found in the lower left-hand portion of the field in Fig. 3, also have circular arcs and are capable of dwell periods. As shown by the path of *point 2* in Fig. 1, this curve is long in the direction in which the radius link is displaced, and a rocker applied to this linkage has a long stroke.

In each of the three diagrams showing motions with dwell, the rocker is pivoted on the oscillating crankshaft in order to secure a simple arrangement. However, the rocker operates just as well if pivoted at many other points. The only requirement is that the rocker be located and proportioned so that one end of the radius link is held at the center of curvature of the circular arc while the other end is traversing the arc. Also, the radius link should exert most of its pull or thrust in a direction at right angles to the rocker arm. For a given path the rocker motion may be varied either by relocating the rocker pivot or by changing the length of the rocker arm. The period of dwell will be unchanged if the correct location of the radius link is preserved.

To study the character of the rocker motion for any given linkage, a scale model can be made with the rocker arm two or three times normal size, so that displacements are large and accurately measured. When displacements are plotted against the crank position, graphical differentiation will give velocity and acceleration curves.

If a given displacement curve is desired with a dwell period not exceeding 120 degrees, a linkage can be developed for uniform, harmonic, or gravity acceleration with a quick return. From a study of all paths the type capable of developing the motion is selected, and an adjustable model constructed of celluloid. If the motion is still too approximate after cutting and trying on a few linkages, a crosshead with guides may be substituted for the rocker.

While the linkage contains more elements than an equivalent cam motion, the linkage is easier to machine than the cam. No springs or highly stressed surfaces are present in the linkage, and no rubbing or bearing surfaces are exposed.

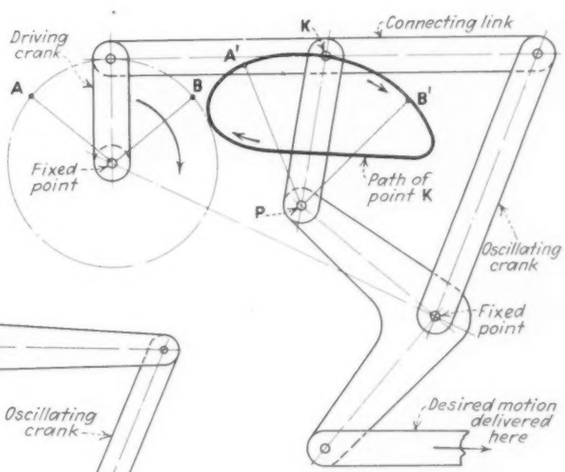


Fig. 5—While the driving crank moves from A to B, point K moves in circular arc and the rocker arm dwells (Point 1 in Fig. 1)

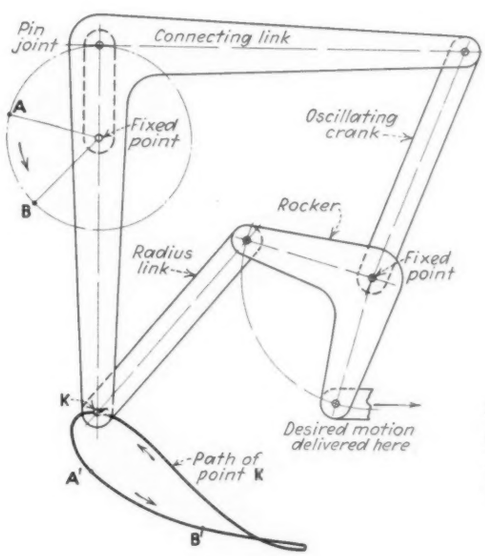


Fig. 6—Dwell period for the rocker is not at the end of the stroke (Point 3 in Fig. 1)

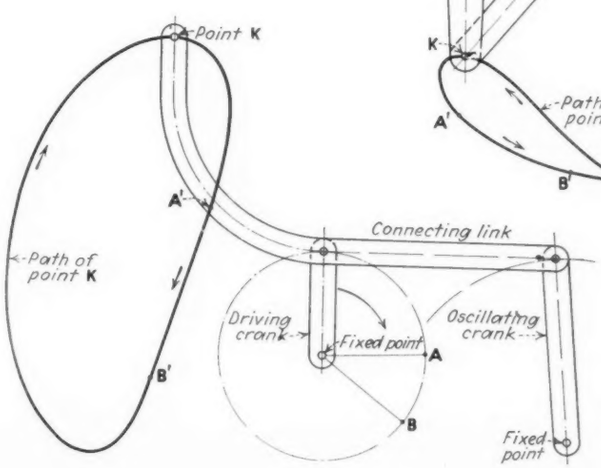


Fig. 7—While the driving crank rotates from A to B in the linkage (below) K moves in a straight line. A number of straight line paths are shown in the left-hand portion of Fig. 3

This article, submitted for exclusive publication in Product Engineering, is based on a thesis study in partial fulfillment of the requirements for a Master of Science degree at Massachusetts Institute of Technology.

QUESTION AND COMMENT

Designing Optical Systems for Sharp Images

O. K. KASPEREIT
Frankford Arsenal

● By assuming that the focal length of the projection lens is equal to the object distance, the design of optical projection systems is sometimes simplified. However, a clear, sharp image will be produced on a screen at any finite distance only if the object distance is determined by the law of the "Conjugate Focii." According to this law, the object distance S in terms of F the focal length of the lens and S' the image distance is given by the relation,

$$\frac{1}{S} + \frac{1}{F} = \frac{1}{S'} \qquad (1)$$

Distances S and S' are measured from the principal planes of the lens or lens system. From Equation (1),

$$F = \frac{SS'}{S - S'} \qquad (2)$$

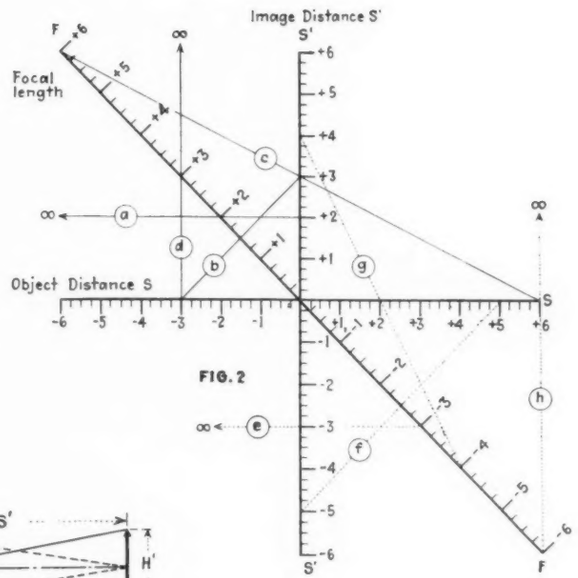


Fig. 2 — Alignment chart solving Equation (1) for converging or diverging lenses designed to give sharp projected images

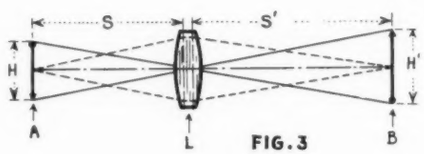
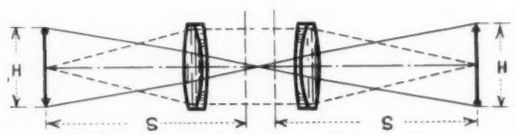


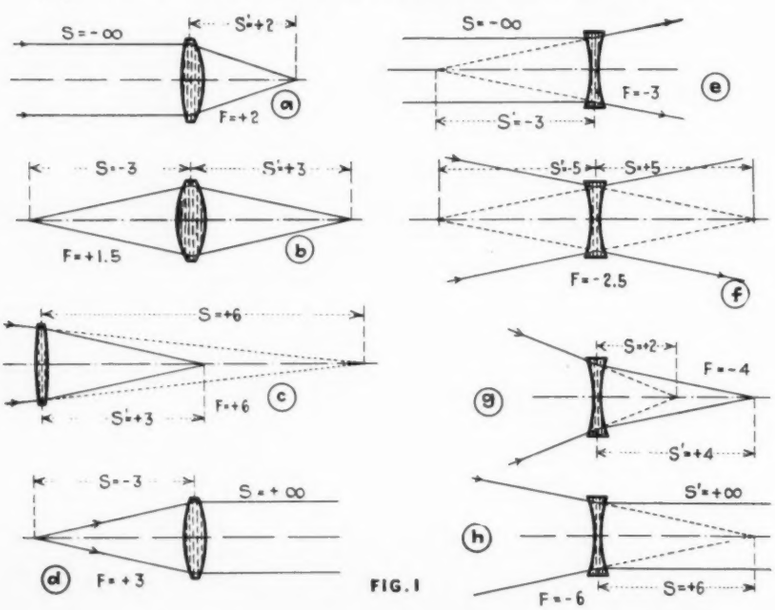
Fig. 3—In telescopic optical systems, the image is erected and magnified



$$S = \frac{FS'}{F - S'} \qquad (3)$$

$$S' = \frac{FS}{F + S} \qquad (4)$$

Fig. 1—Types of converging lenses (left) and diverging lenses (right) with constants used in examples shown in alignment chart



These relations are shown in Fig. 1, for four types of converging lenses and four diverging lenses. The constants of the optical system, given with each example, can be computed from Equations (2) or (4) when two of the constants are given, or the constants can be read directly from Fig. 2, an alignment chart constructed for these equations. Examples shown on the chart are solutions for each of the optical systems illustrated.

In order to erect the inverted image formed by a telescope objective, as well as to obtain the required magnification, lens erecting systems are employed in telescopic systems. In Fig. 3, the single thick lens L inverts the image A giving an erect one at B, at the same time changing the relative size of these images. Equations (1) to (4) also apply to the erecting system, but another factor also enters—the magnification of the system. In

terms of the diameters of the inverted image H and the erected image H', the magnification M is:

$$M = -\frac{S'}{S} = \frac{H'}{H} \qquad (5)$$

By combining Equations (1) and (5) the following relations are obtained for erecting systems:

$$F = \frac{S'}{M+1} \qquad (6)$$

$$S = -\frac{S'}{M} \qquad (7)$$

$$S' = -MS = F(M+1) \qquad (8)$$

Six scales are required to form a chart for an erecting system. However, the chart can be simplified by combining several of the scales into one. As shown in Fig. 4, the object distance S, the diameter H of the inverted image, and the focal length F of the erecting system can be laid off on scale A. Scale B represents image distance S' and the diameter H' of the

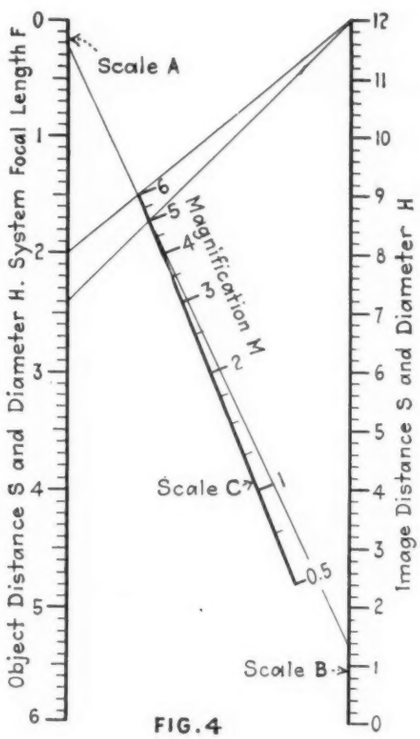


Fig. 4—Chart solving Equations (5), (6) and (7) for erecting optical systems. Construction lines are for the example given in the article

erected image. Scale C gives M the magnitude of the magnification. The magnification of an erecting system is relatively low and varies between the limits of 0.5 and 5. The object distance S is negative, and the image distance S' and the focal length F are positive in all cases.

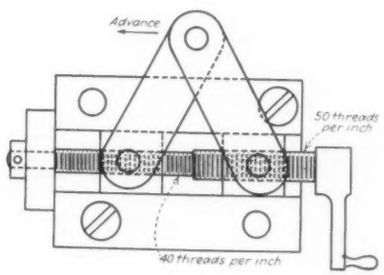
For an erecting system with a focal length of 2 in., with an image 0.25 in. in diameter magnified five times, the example shown on the chart gives the object and image distance. The line from *2* on the A scale is drawn through $M + 1$ or *6* on scale C, cutting the B scale at a value of *12* for the image distance. A line from this point through *5* on scale C, gives a value of *2.4* for the object distance on the A scale. A third line from *0.25* on scale H through *5* on scale C, gives the image diameter of *1.25* on the H scale.

Differential Threads

To the Editor:

● The design advantage in using differential threads is often overlooked, although this principle has many applications, such as the one shown here.

This principle can be applied in making accurate adjustments of machine members, for adjusting the lengths of slide bars operated by cams in automatic machines, or for compensating for abrasive wear on grinding wheels used on concrete work. In the accompanying illustration, two nuts sliding in a channel are driven by a shaft cut with 50 and 40 threads per



Design using differential threads to produce accurate adjustments

in. The lead in one turn for 50 threads per in. is 0.020 in., and for 40 threads per in. is 0.025 in. Therefore, if the crank is revolved one turn, the linkage will advance a distance which is the difference between these threads, or 0.005 in. Thus, 200 turns of the crank will be required for 1 in. advance.

The same principle can be used for accurate gages for measuring small distances, or when it is desirable to use a large reading space on a graduated dial. For example, a double-thread spindle can be cut with differential threads that are 100 and 99 per in., giving a difference in lead of 0.0001 in. for one turn of the graduated barrel. To open the jaws of the micrometer a distance of 1 in. will require 10,000 turns.

—C. W. HINMAN
Atlanta, Ga.

Special Centers With Standard Cutters

To the Editor:

● In *Product Engineering* for April, page 149, Prof. J. A. Hall of Brown University, cites a type of gear problem with which many young graduate designers are confronted, but unfortunately they are not taught the method of attack. The only method that is taught is the original Brown & Sharpe system of gearing with its inflexible rules. Too often the student graduates with the understanding that no other method is available.

One solution of this problem, prepared by a senior engineering student at a midwestern university, requires modified teeth only on the gear. As given in the statement of the problem, the present gear combination is 36 and 159 teeth, 20 D.P., 20 deg. pressure angle, full depth teeth. The pinion pitch diameter is 1.800 in., and the outside diameter is 1.900 in. The gear pitch diameter is 7.950 in. The center distance is 4.875 for both the present and the new ratio. With the required 4-to-1 ratio, the maximum outside diameter of 2.000 for the pinion cannot be exceeded.

The maximum number of 20-D.P. teeth that can be used in the pinion is 38, giving 2.000 in. for the outside diameter. The gear pitch radius, therefore is 3.925 in., and the 4-to-1 ratio requires 152 teeth in the gear.

The 38-tooth pinion is generated in the usual manner on the Fellows No. 65 gear shaper. The mating gear is machined to 7.950 in., the correct outside diameter for a standard 157 tooth, 20 D.P. gear. But, instead of cutting 157 teeth in this gear, the gear shaper is set to generate 152 teeth. The involutes generated on this gear are developed from the base circle of a 152-tooth gear instead of from the base circle of a standard 157-tooth gear.

For this non-standard gear having a pitch diameter of 7.850 in., the cosine of its pressure angle is equal to the base circle diameter of the standard gear divided by the pitch diameter. With the new gear combination, the special gear has a pressure angle of 24 deg., 32 min.

The increased bearing load caused by the increased pressure angle is proportional to the secant of the pressure angle, and in this problem

amounts to approximately 3 per cent.

If there is doubt as to adequate tooth contact, this pair of gears can be converted readily into Fellows 23 deg. helical gears with the tooth proportions computed on the diametral plane in the same way as for a spur gear.

—A. F. BARKER
University of Michigan

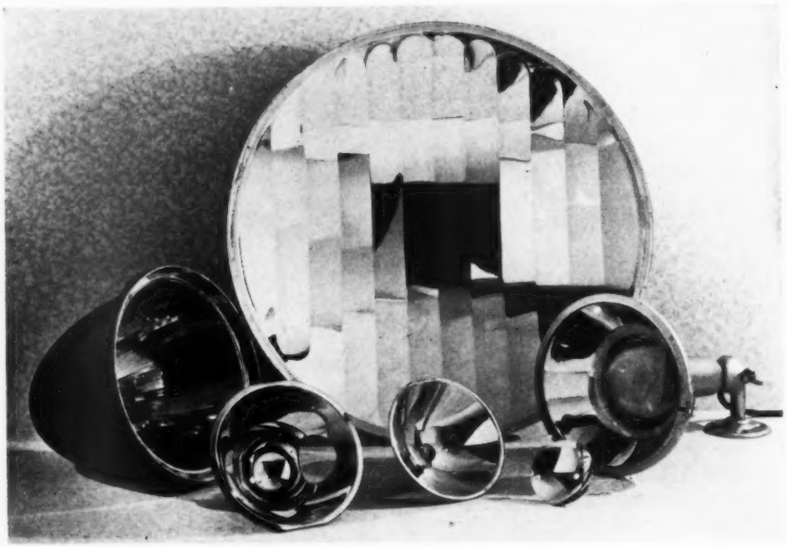
Rhodium Surfaces For Metal Reflectors

BLASIUS BART
Bart Laboratories
Belleville, N. J.

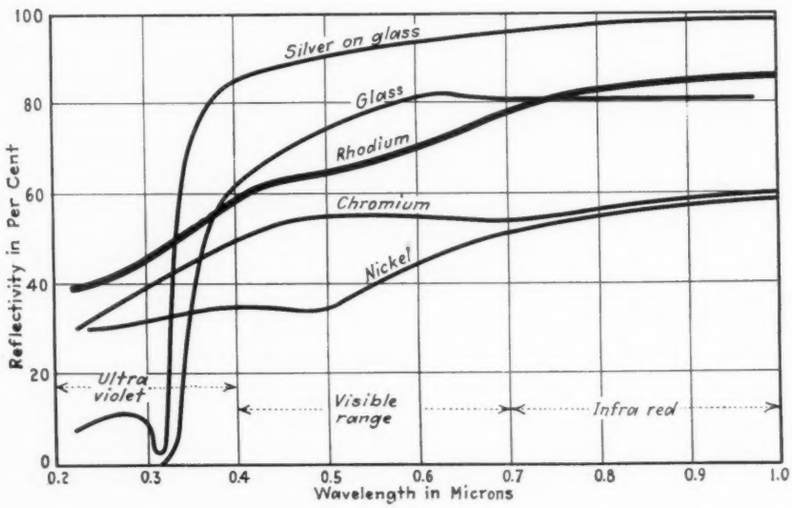
● Reflectors made of spun, stamped or pressed metal have an optical accuracy of relatively low order since resilience in the metal causes some change in shape on relief of forming pressure. Distortion in service may arise from internal stresses set up in the forming process or differences in temperature throughout the reflector.

High optical accuracy can be obtained with glass reflectors, but the optical contour and surface finish must be mechanically produced on each part. The final accuracy in glass surfaces is subject to relatively large differences caused by human errors. Inaccuracies at the edges of large reflectors are relatively great, particularly on reflectors used on large searchlights.

By electrically depositing metal on a master mold high optical accuracy can be obtained in metal reflectors. When the reflector shell is taken off the mold, it bears a surface identical to the master and requires no subsequent polishing. The reflecting surface is reproduced with an accuracy of the order of millionths of an inch.



Rhodium-plated mirrors and reflectors formed by electrodeposition on molds of special shapes



As compared with other materials rhodium has excellent reflectivity over the entire range of wavelengths

Rhodium surfaces on metal reflectors in Sperry searchlights are unaffected by heat from the arc

Although great care and precision are needed in producing the master molds for the plating process, this laborious and painstaking work has to be performed but once. For this reason it is economically possible to devote considerable effort to approach optical perfection in the master molds.

Since the principal mass of the reflector is electrically deposited copper or nickel having high thermal conductivity, temperature gradients and consequent distortions are eliminated when the reflectors are used with high-intensity light sources. Metal structures are also less subject to shock and can be mounted and supported better than glass reflectors.

As the electrically deposited shell is a first-surface reflector, the effects of refraction, transmission and reflections from secondary surfaces are absent. By the use of a surface that is unaf-

fected by atmospheric conditions, the reflector does not require the protection of lacquer or other films, avoiding errors caused by the refractive index of such coatings.

For durability under exposed weather conditions and the high temperatures accompanying arc lights, a reflecting surface of rhodium is used, backed by a deposited nickel or copper base. Except for its higher hardness, rhodium metal is similar to platinum in physical characteristics, but it has the unusual property of high specular reflection over a wider color range than found in any other reflector material. The rhodium surface is many times harder than silver, is non-oxidizing, resistant to heat, and is unaffected by industrial or chemical fumes and products of combustion. Rhodium is easily deposited giving a bright finish that does not require polishing. Although the metal cost is approximately twice as high as the cost of platinum only a thin plated surface is needed.

When the light source is an arc, as in searchlight and motion picture projectors, slag droplets thrown on the surface of the reflectors do not attach themselves to rhodium reflecting surface because of the rapid thermal absorption of the metal. Heat itself does not impair the surface even at temperatures that would destroy a glass mirror.

Comparisons of efficiency with other types of reflectors are based on the overall efficiency referred to silver backed glass mirrors. The average specular reflection factor for light from an incandescent lamp is 75.7 per cent. On this basis, the metal mirror starts with a 5 to 10 per cent handicap as compared to a new glass mirror, but the rhodium-plated surface holds its value where the glass mirror depreciates. The rhodium surface is not color selective, and is efficient in the ultraviolet region of the spectrum where the reflectivity of other metals is either low or absent.

Precision rhodium-plated mirrors are competitive in price with glass mirrors in their class, and are progressively cheaper than glass mirrors for higher optical precision. Time is indirectly a factor of costs, but the rate of production is independent of expert labor. In addition to optical accuracy the process of reproducing the optical surfaces from metal molds makes possible the use of special reflector contours and pebbled or fluted surfaces to give the desired light distribution for special applications.

Bimetal Arc Control

PRESTON BASSET
Chief Engineer
Sperry Gyroscope Company

● In the Sperry arc control mechanism for searchlights, the positive feed device rotates the positive carbon to maintain an even crater edge, and at the same time feeds the carbon forward. The rate of feed is slightly less than the rate at which the carbon is consumed, resulting in a gradual recession of the crater edge from its original position at the focus of the mirror.

By means of a lens, light from the crater is projected onto a cover over a bimetal element. When the crater edge is at the focus of the mirror, the projected light falls just at the edge of a slit in the housing, but a recession of the crater edge of only $\frac{1}{64}$ in. shifts the projected crater image until a portion falls through the slit.

Heat in the light beam passing through the slit is sufficient to cause the bimetal strip to bend and close electrical contacts. The contacts complete the circuit to an electro-magnet, which trips a mechanism for accelerating the positive feed. The accelerated feed continues until the carbon has been fed forward $\frac{3}{32}$ in., thereby causing the projected light spot to move away from the slit, allowing the bimetal strip to cool and open the contacts releasing the accelerated feed. With the position of the positive crater held to within $\frac{3}{32}$ in., no variation is apparent in the appearance of the searchlight beam.

Provision is made in the design of the thermostat to insure accurate control of the positive feed over a wide variation in the operating temperature. Compensation is obtained by attaching a second bimetal strip to the active strip. The compensating element warps to an equal extent in an opposite direction to that in which the active element moves. The temperature of the complete thermostat can be varied over a range of 100 deg. C. without causing any variations in the gap between the contacts.

To minimize warping at right angles to the direction of the required motion, both elements are slotted lengthwise into four $\frac{1}{8}$-in. strips. The two bimetal elements and the contact arm are riveted together, and the complete assembly is aged in an oven at 110 deg. C. for 24 hours. The thermostat is then adjusted for proper arc operation when first placed in the searchlight. With this stabilizing treatment, the arc control can be operated for years without further adjustment.

Confused Nomenclature

To the Editor:

● Constant effort is being made towards simplification of the English language to avoid the necessity for too elaborate a vocabulary. While such an effort is commendable, there are times when it works to the disadvantage of engineers. For example, in the article "Data for U-Leather Packings," in the June number, the word "hydraulic," was used in its original sense as a system utilizing water as a working fluid. Webster's dictionary defines the adjective "hydraulic" as pertaining to "water or fluid in motion." But the inclusion of the word "fluid" is not generally acceptable since that would include gases, for which the term pneumatic is used. But in the more than twenty examples given by Webster for the adjective "hydraulic" water is specified in every instance as the "working medium."

The general conception of a "hydraulic" system is one that utilizes water or other liquid. Some engineers think only of oil-filled systems. Dr. Hele Shaw endeavored to clear this particular point up some years ago by introducing the term "elaulic" for oil-operated systems, but for some reason it never caught on.

An outgrowth of the difficulty is the term "hydraulic coupling," which may mean any of several different things. It may mean displacement equipment and clutches or turbo-equipment of the Fottinger type, the turbo-equipment being of one or the other of two distinct types—those capable of torque conversion and those incapable of torque conversion. The *Power & Works Engineer,* London, suggests the terms "fluid-displacement coupling" for displacement equipment, "torque converter" for turbo-equipment capable of torque conversion, and "turbo-coupling" for that incapable of such conversion, such as drives used for fans and stokers.

Whether these names be accepted or not, some definite and distinctive ones should be chosen, to avoid any danger of misunderstanding or misconception. The same reasoning might apply in the more general use of the term "compression-ignition engine" to describe the units popularly called "Diesels," which today bear but little resemblance to Dr. Diesel's original designs. The term "mutator" is a distinctive term applying to the group of electrical units such as the mercury-arc rectifier. Some simple distinction is needed between turbine-generators driven by water and those driven by steam.

—E. J. TANGERMAN
New York, N. Y.

Anti-Friction Bearings

E. WOOLER

Typical ball and roller bearing mountings as applied to wheels, transmission, final drive, steering gear, universal joint, fan, generator and other locations in passenger cars, trucks and buses

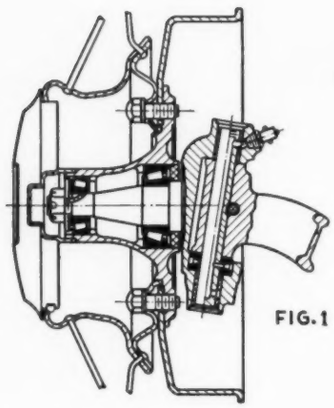


FIG. 1

Fig. 1—A conventional front-wheel bearing mounting for passenger cars. Adjustment is made by the hex nut and keyed washer next to the outer bearing. The thrust of the steering pivot is taken by a flat-type roller bearing.

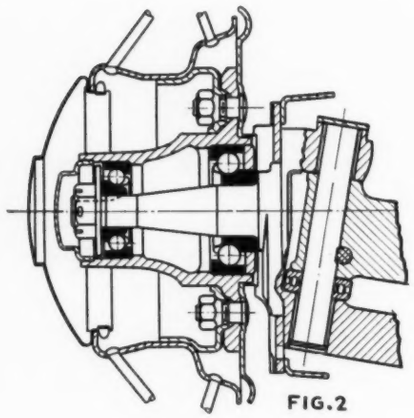


FIG. 2

Fig. 2—Similar to Fig. 1, except open-type ball bearings are used instead of roller bearings. These ball bearings are constructed to take heavy side thrust and are mounted opposed. Adjustment is the same as in Fig. 1. The steering pivot bearing thrust is taken on a flat-type ball thrust bearing.

Fig. 3—A front-wheel application for a commercial vehicle. The wheel bearings are similar to those in Fig. 1, but the steering pivot is mounted on steep angle taper roller bearings that take both radial and end thrust.

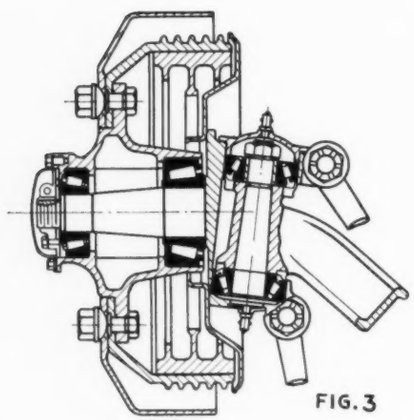


FIG. 3

Fig. 4—A straight roller bearing is used for rear-wheel mountings in which the inner race is pressed on the outside of the axle housing and riveted. The side thrust is taken on the differential bearings by locking the differential side gear on the spline at the inner end of the axle shaft.

Fig. 5—The inner race or cone is pressed on the rear axle shaft against a shoulder or on a taper. This necessitates butting both axle shafts directly together, or taking the load through a thrust block at the center of the differential. Shims are placed between the flange of the housing and the brake carrier plate for adjustment. As an alternate method the bearing retainer can be threaded and locked by a clamp bolt.

Fig. 6—To eliminate the necessity of forming the large shoulder on the rear axle shaft, as in Fig. 7, the bearing cones are pressed

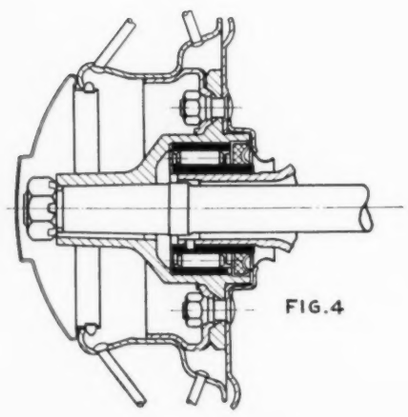


FIG. 4

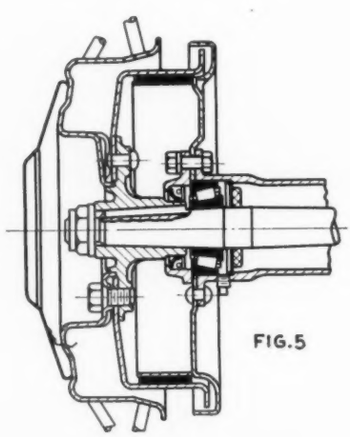


FIG. 5

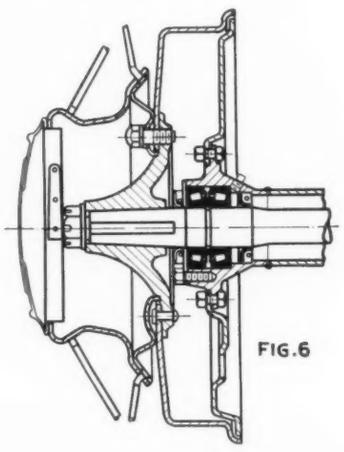


FIG. 6

in Automobiles—I

directly against each other. These cones are made with a large radius at the back-face. A small shoulder or wrinkle is formed on the shaft which projects up into the space formed between the radii of the cones. This shoulder has clearance between the bearing cones and acts only as a safety. The design depends on a definite tight press fit of the cones, but should a cone become loose the small shoulder prevents the axle shafe from working out.

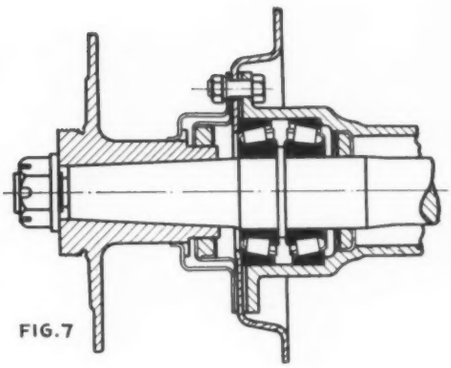


FIG.7

Fig. 7—The double bearing construction eliminates the necessity of butting the axle shafts at the center and absorbs the wheel thrust in both directions within the bearings at each end of the axle. The cones are pressed on the axle shaft against a shoulder. The bearing cups are mounted directly into the end of the axle housing and provision for bearing adjustment is made by means of shims.

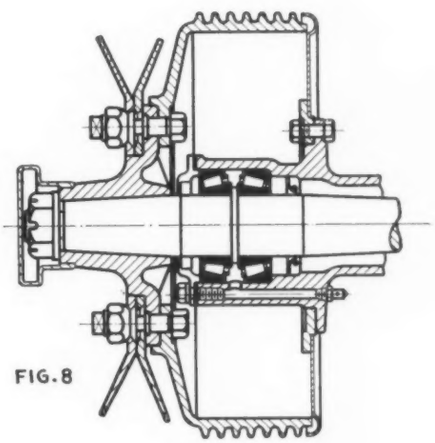


FIG.8

Fig. 8—A common form of double bearing mounting in larger semi-floating rear axles for truck or bus. Bearing cones are pressed against the axle shaft shoulder, as in Fig. 7, but the sealing is different. Shims are provided next to the retainer cap for bearing adjustment.

Fig. 9—Full floating construction is used on some of the larger passenger car and truck rear axles. The bearings are spread sufficiently to give ample rigidity to the rear-wheel assembly. This is especially necessary with the use of dual tires.

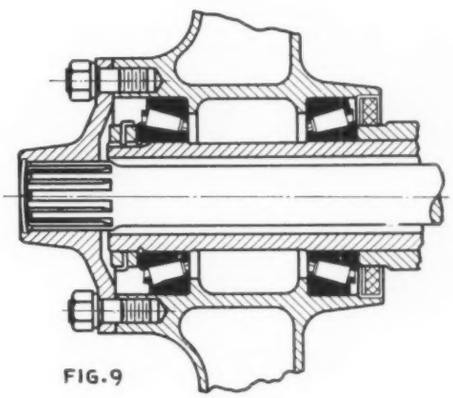


FIG.9

Fig. 10—The two tapered roller bearings are spread apart in the fan assembly of a commercial vehicle. The belt load is applied between the bearings. One end only need be sealed, the fan covering up the bearing at the other end.

Fig. 11—Similar to Fig. 12, except that two tapered roller bearings abutting each other are used. The bearing cap is shimmed and held on the fillister capscrews.

Fig. 12—The double row of ball bearing mounting for a fan and water pump is mounted directly below the belt pulley so that shaft deflection does not take place. The pump impeller end runs in a bronze sleeve bearing.

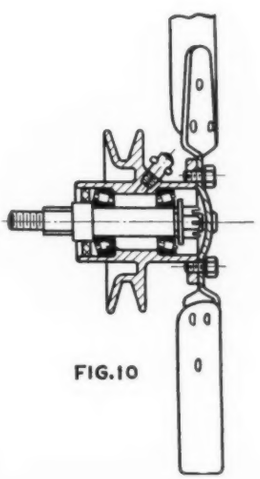


FIG.10

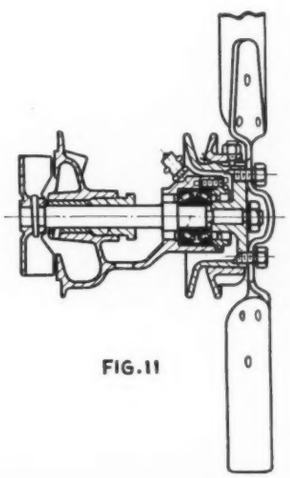


FIG.11

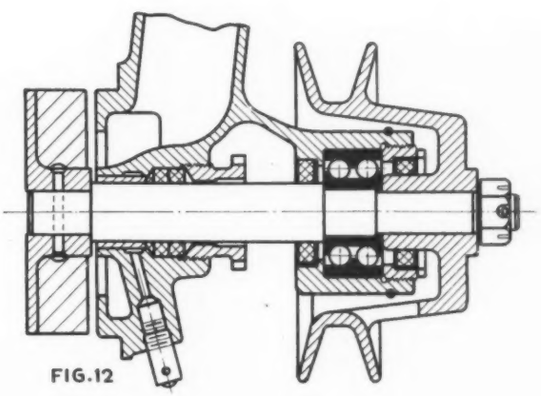


FIG.12

NEWS

ECPD to Accredit Engineering Schools

THE Engineers' Council for Professional Development sponsored by the leading national engineering societies, the engineering educators, and the engineering examiners have announced the inauguration of a program for accrediting engineering schools in New England and the Middle Atlantic States. The program will be offered to the other parts of the country after a trial period in these two regions. Notice is being sent to the presidents of all degree-granting engineering schools in the two areas advising them that the Engineers' Council stands ready to receive requests for consideration of particular engineering curricula which the schools may wish to submit.

Through the ECPD Committee on Engineering Schools, regional subcommittees have been organized to visit each institution requesting recognition for its curricula. The visits by these committees will begin early in the fall and it is expected that the accrediting in these regions will be well under way before the first of the year. The plans and procedures will be considered in the light of the experience in carrying out the accrediting process in these regions, and with such modifications as seem desirable, the plan will then be offered to the other parts of the country.

Accrediting is necessary at the present time for a number of reasons, the most urgent of which is the fact that a majority of the states have enacted laws for the licensing of engineers, and that licensing procedure requires a list of accredited colleges whose graduates may submit evidence of their graduation in partial fulfillment of the requirements of licensing. The Engineers' Council for Professional Development is undertaking this work because it is the only body which represents all of the interested groups: the engineering schools, the state licensing boards, and the national engineering societies.

While the primary purpose of ECPD through its Committee on Engineering Schools is to identify those institutions which offer professional curricula in engineering worthy of recognition as such, in longer range the purpose is to aid in promoting the best interests of engineering education and to raise the general level of its effectiveness. Emphasis will be given to quality of work, rather than to statistical information, to a greater degree than in former accrediting procedures. No hard and fast prescriptions are laid down for curricula, physical facilities, investments or expenditures, or other specific points relating to a given institution, although all of these, and others, will be taken into account in appraising the institution as a whole.

Great progress has been made in certain of the professions in raising the standards of their professional schools. The most notable of these is the medical profession. It is believed that this program of ECPD is an important part of the broader plan for enhancing the status of the engineering profession.

Ford Using New Rust-Proofing Process

AN entirely new method of rust proofing which for the first time utilizes alternating current, is now being used on the entire production of head and tail lamps at the Ford Flat Rock, Mich., plant.

When Ford began the use of synthetic enamel for lamps, it was found necessary to provide a rust-proofing treatment which would easily fit into the highly organized and mechanized unit at the Flat Rock plant. The problem was solved by the adoption of a new process developed by the American Chemical Paint Company for coating the lamp shells in a bath which, it is claimed, develops a film possessing outstanding rust resistance and paint adherent qualities. The minimum requirement under Ford specifications is 300 hours in salt spray without a break in the finish, but the new lamp finish, comprising a protective film, one undercoat, and one enamel coat, exceeds Ford's specifications over three times without showing failure.

The entire process consists of two independent units, each unit consisting of a cold water rinse tank, a hot water rinse tank and a processing tank equipped with copper electrodes which are suspended in the bath in the form of baffles, and which are supported by an electrical contact with one end of the tank and a copper post rising from the bottom of the tank. The electrodes clear the bottom of the tank and are perforated to permit free circulation of the bath solution. The energized bath contains a solution of chemicals chiefly zinc phosphates and a toner or oxidizer in a definite proportion. The toner is used to convert whatever ferrous phosphate may be developed, into ferric phosphate which is insoluble and sinks to the bottom of the tank.

Electrically the bath is controlled by a special 250 KVA transformer and an oil-type switch located in the tanks. The voltage impressed on the bath is 20 volts, the current density ranging from 35 to 50 amperes per sq.ft. A significant feature of this alternating current bath is that a normal temperature of 155 deg. F. is maintained without the use of auxiliary heating equipment.

When the lamp shells emerge from the electrolytic bath, in which the cycle is only 4½ min., the work moves directly into a cold water spray and then through a hot water tank. The shells are moved through the entire cycle on a fully automatic plating conveyor arranged to rise and fall in and out of the tank in the usual manner. Copper hooks carrying four lamp shells each are used to fasten the work on the conveyor, since good electrical conductivity is important.

When the shells emerge from the bath, they pass through a dryer and proceed to the paint department. Prior to finishing, the lamp bodies are prepared by merely wiping with a chamois, and then hooked on a long bar which carries them through the drying oven. With the carrier held at both ends by workmen, the lamps are immersed in a tank containing the primer, held up to drip, and then mounted on a conveyor for a trip through the drying oven. After the drying of the primer coat, the work is lightly sanded, dipped into a tank containing synthetic enamel, and again passed through the drying oven.

Reducer Ratings Now Standardized

BECAUSE there were no standardized ratings, buyers of speed reducers have for many years found it difficult to determine the comparative worth of such equipment offered them by various manufacturers. Manufac-

turers, in turn, have never known if they were in fair competition with other manufacturers interested in getting the business.

To solve this problem, the American Gear Manufacturers Association appointed technical committees to work out a standardized measure of rating for adoption by the association. These committees devoted several years' study to the problem, and recently presented for adoption by the A.G.M.A. a set of "Recommended Practices for Rating Helical and Herringbone Speed Reducers and Heavy-duty Worm Gear Speed Reducers." Adoption of these recommendations by almost unaminous assent of the association indicates that they fill a long-felt want and are of signal value to both buyers and manufacturers.

There is real need for such a standardized measure of rating. To simply say that a reducer is good for so much horsepower at a certain speed, without any reference to the stresses, limitation of wear in the teeth, and other such factors, is like comparing two electric motors of the same horsepower and speed, yet with different limits of temperature rise.

Under the "Recommended Practices for Rating Helical and Herringbone Speed Reducers and Heavy-Duty Worm Gear Speed Reducers," the different types of service encountered in every day use are now indicated by a service factor or class. As a result, the buyer of a speed reducer who specifies an A.G.M.A. rating of the service factor or class wanted can be sure of getting what he specified. Likewise, each manufacturer seeking the business knows he is competing for that business in a fair competitive way.

Beryllium Dies for Molding Plastics

CAST beryllium-copper dies for making molded plastics, recently developed by the Bronze Division of the Gorham Company, enable considerable saving in the die cost over the use of machined steel dies. Beryllium copper is cast around plaster patterns, reproducing irregular contours, decorative detail and surface finish with high accuracy. The cast molds are then hardened by a heat-treatment that does not alter the shape or proportions of the die, since rapid cooling is not required.

This development is primarily of interest in the production of molded parts requiring ornamentation or detail, since expensive die sinking and finishing operations are eliminated. The cast beryllium-copper dies are also being used to reduce the cost of sample parts or short runs where present methods of die manufacture are not economical. For such articles as medallions, nameplates, box lids, buttons and novelties, the use of the cast dies requiring no subsequent finishing offers new opportunities for improvement in appearance. The greater economy of the cast beryllium-copper dies opens new possibilities in the use of molded plastics.

Rule for Worm Gear Efficiency Verified

THE commonly used empirical rule for estimating the per cent efficiency of a worm gear, 100 minus one-half the speed ratio, was verified in a series of tests reported recently by the engineers of the Worm Gear Department of the DeLaval Steam Turbine Company.

The principal dimensions of the gears tested were as follows: distance between centers, 10.25 in.; 1.6718 in. circular pitch of worm wheel; 6⅜ ratio of transmission, 40 deg. 10 min. helix angle. The worms were of hardened steel and ground, 5 threads, with the worm shaft at the bottom and mounted in ball bearings. The wheel shaft was mounted in sleeve bearings. Lubrication was by the splash system.

Two gears were coupled together, one as a step-down gear and the other as a speed-up gear. A calibrated motor was coupled to the worm shaft of one gear, while the worm shaft of the other gear was coupled to a similar calibrated motor used as a generator, the wheel shaft of the two gears being coupled together. The efficiency of the gears was determined by measuring the electrical input and output. The efficiencies of both motor and generator were known from previous tests, but were also checked by computation of the stray loss and the RI square loss for each unit. By taking readings of the current input and the voltage at the motor, and the same readings at the generator, the power loss in the worm gear drives can be computed, corrections being made for the motor and generator losses.

Readings were taken after the gears had run at full load for eight hours and the oil in the gear casings had assumed a constant temperature. From this data the combined efficiency of the two gears in series was calculated to be 91.54 per cent. On the assumption that the losses were distributed between the two gears in the same proportion as their respective temperature rises, it was calculated that their efficiency was 95.3 per cent and 96.13 per cent. In a second series of tests with the power applied in the reverse direction, the efficiency of the gear with the worm driving was found to be 96.7 per cent.

Applying the empirical rules, the efficiency of these worm gears calculate 100—(6-3/5/2) which equals 96.7. Applying the rational formula for efficiency with the worm driving is:

$$Efficiency = \tan\alpha/\tan(\alpha + \phi)$$

In this equation α is the helix angle and ϕ is the angle of friction.

Using the coefficient of friction of 0.0197 as established in a recent paper by Dr. H. E. Merritt of England, the efficiency is calculated as 96.57 per cent, which is close to 96.7 per cent as found by test. It may be expected that after more extended running the efficiency of the gears will increase somewhat, thus bringing the actual test efficiency closer to the calculated efficiency. But even the test results given above show remarkably close agreement with the efficiences calculated from empirical and rational formulas.

MEETINGS

American Society of Mechanical Engineers—Machine Shop Practice Division, Hotel Statler, Cleveland, Ohio. Sept. 11-12. C. E. Davies, secretary, 29 West 39th St., New York, N. Y.

National Metal Congress—Palmer House, Chicago, Ill. Sept. 30-Oct. 4, the following societies participating:

American Institute of Mining and Metallurgical Engineers—John T. Breunich, assistant secretary, 29 West 39th St., New York, N. Y.

American Society for Metals — W. H. Eisenman, secretary, 7016 Euclid Ave., Cleveland, Ohio.

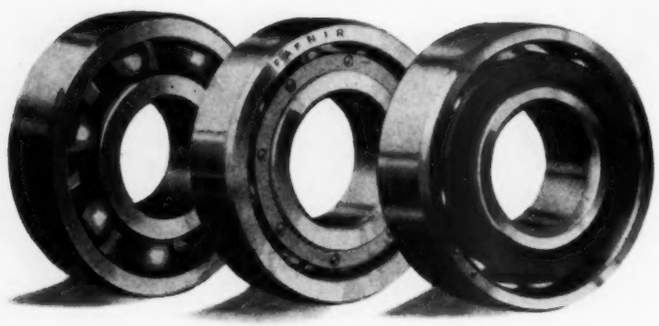
American Welding Society—Miss M. M. Kelly, secretary, 29 West 39th St., New York, N. Y.

EXHIBITIONS

National Electrical and Radio Exposition — Grand Central Palace, New York, N. Y., Sept. 18-28. Ralph Neumuller, managing director, Grand Central Palace, N. Y.

National Metals Exposition—International Amphitheater, Chicago, Ill., Sept. 30-Oct. 4. W. H. Eisenman, general manager, 7016 Euclid Ave., Cleveland, Ohio.

New Materials and Parts

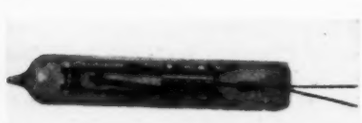


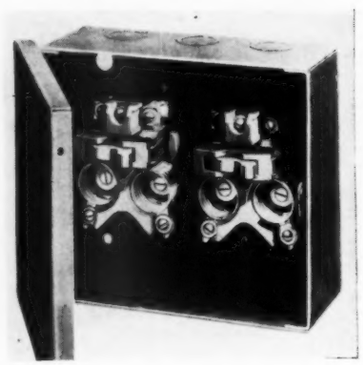
Precision Ball Bearings

Three new types for high speed where extreme accuracy is required. Are of single row, deep-groove type, with rings and balls of high-carbon chrome steel. Standards of accuracy are said to be finer than S.A.E. specifications. Type M are available for light, medium or heavy loads. Type WW are equipped with a ring-piloted bronze retainer to assure absolute concentricity in operation, and are used for high-speed woodworking machinery. Type MM is for high-speed machinery and other special fields. Available with composition retainers for lightness in weight and exact running balance. Standard sizes 10 to 110 mm. bore for the light series, and 17 to 55 mm. bore in the medium series are available. Fafnir Bearing Co., New Britain, Conn.

Temperature Control

Is used in water-cooled internal combustion engines to sound an alarm when a predetermined temperature is reached, to hold the water temperature constant by varying the flow or to cut off the ignition by opening the primary of the ignition coil or by grounding out the magneto. The control is completely sealed in a glass tube from which all air has been evacuated and replaced by an inert gas. It is said that the contact points cannot oxidize or become pitted and are tamper proof. Thomas A. Edison, Inc., West Orange, N. J.





Dual Hot Water Heater Switch

For disconnect use with two-element electric hot water heaters. The switch consists of two 30-amp., 2-pole plug-fuse individual switch bases in one inclosure. The switches are front operated for compactness and sealing provisions are made. Can also be used for installations where the heater is usually operated on "off" peak load, but provision is made to cut in the heater at regular rates when the occasion demands. Square D Co., Detroit, Mich.

Paper-Insulated Cable

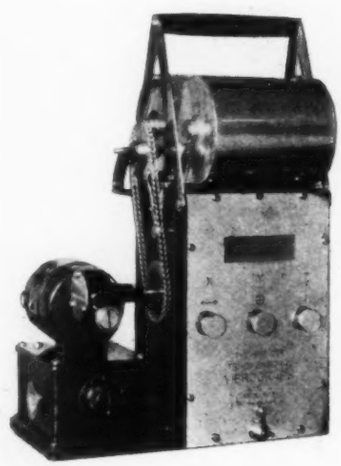
Improvements have been made in the construction of this cable to give a smaller outside diameter, and said to withstand higher di-electric strength, to lower the a.c. resistance and to have longer life. Layers of insulation are graduated, with super-dense paper next to the conductor to improve mechanical and dielectric strength. The lead sheath is applied by special hydrogen process to eliminate oxidized areas. Metal shields are interlocked with paper tapes for better shielding. General Electric Co., Schenectady, N. Y.

Copper Alloy

Known as Mallory 3 Metal, this material is used for scoreless commutator segments in motors and generators, overhead wire for electrical railways, for telephone and telegraph service, and for spot welding tips, flash welding dies and seam welding wheels. Said to have high electrical conductivity and great mechanical strength. Can be forged and sand cast. P. R. Mallory & Co., Inc., Indianapolis, Ind.

Shrader Vibrograph

Measures simultaneously all three components of vibration, giving amplitude, wave form, frequency and phase relation. Instrument is a form of seismograph recording as well as indicating vibration components in one vertical and two horizontal directions. A heavy mass is supported and held in position by springs. Relative motions between the mass and the frame are indicated on a screen by beams of light reflected from concave mirrors attached to spindles on the mass. Light source is a 2.5 volt flashlight bulb with series resistance for 110 volts. Timing device consists of a magnetic vibrator which also reflects a beam of light to



the screen with interruptions at power line frequency. Film record is made on 70 mm. positive motion picture film carried in a detachable film holder which clamps to the top of the instrument as shown. A deflecting mirror throws the light beams either to the screen or to the film as required. Rotating mirror supplied can be used instead of the film holder for visual examination of wave form. Motor speed adjustable over a wide range. Vibration Specialty Co., 1534 Winter St., Philadelphia, Pa.

Protective Coating

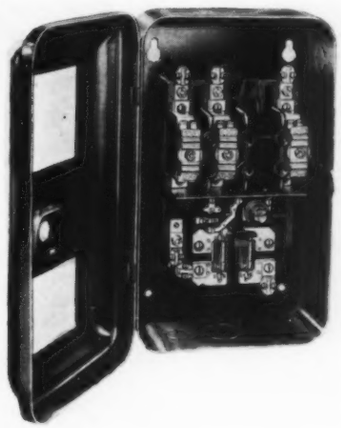
It is applied in liquid form by brushing, spraying or dipping to seal the surface against air or moisture. Can be used as a rust preventative when storing metal parts or when shipping finished products. When plating metal parts, "Kelsanite" can be used for masking to prevent deposition of plate, except where desired. It is said to withstand salt spray tests over a long period without showing signs of corrosion. The skin-like covering can be readily stripped off parts when so treated. The Kelsan Products Co., St. Clair, Mich.

Midget Relay

"Aminco" Midget supersensitive relay for use with mercury and bimetal thermoregulators and other devices with delicate contacts. It is said to operate positively in the plate circuit of a vacuum tube or in other high resistance circuits. Contacts are rated at 1 amp. for 115 volts a.c. with the armature adjusted for a coil current of 7 milliamperes. The relay is mounted on a molded bakelite base with a dust-proof bakelite cover. Will operate when mounted in any position. Minimum operating voltage is 6 volts. The relay is $3\frac{7}{8}$ in. long, $2\frac{1}{16}$ in. wide and $2\frac{1}{8}$ in. high. American Instrument Co., Inc., 774-776 Girard St., N.W., Washington, D. C.

Starting Switch

Type MS magnetic motor starting switch is so arranged that each pole is broken at two points to minimize arcing. The mechanism is actuated



by an electro magnet, the self-adjusting contacts being kept clean by a wiping motion as they seat. Calibrated thermal relay heaters, mounted on the front of the switch block, control the switching mechanism. When sustained overload occurs, the heaters react on a bimetallic thermostat which trips the switch. The switching mechanism, mounted on bakelite, is removable to facilitate wiring. Made in two sizes up to $7\frac{1}{2}$ hp. for local control and up to 25 hp. for remote control. Either style available for 25, 50 or 60 cycles a.c. motors in standard voltage ratings. Colt's Patent Fire Arms Mfg. Co., Hartford, Conn.

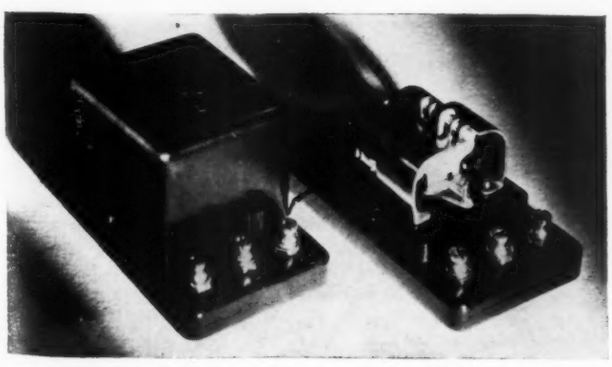
Position Transmitter and Recorder

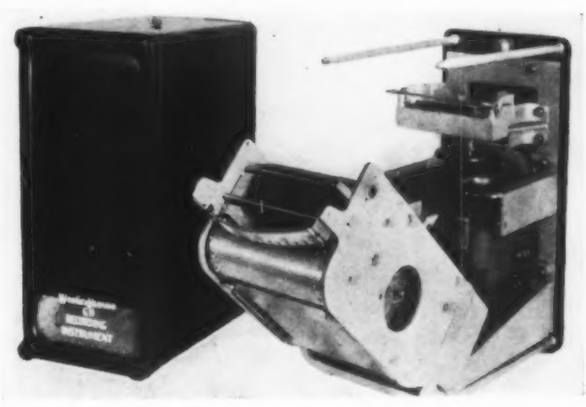
A duplicate position telemeter system for indicating and recording at a distance the position of valves, engine governors or other important mechanisms. Assembled in a rectangular case for switchboard panel mounting. An improved duplicate position type of motor operates a direct-acting pen that records on a strip-type chart variations in the position of remotely associated mechanisms operating a motor-type transmitter. Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa.

Small Drum Switch

Small size, high capacity, a.c. or d.c. drum type reversing switch. For across-the-line starting with "Twin-break" contacts and molded arc barriers. Arcing parts can be renewed,

movable contacts can be removed and stationary contacts, housed in a molded base can be replaced by removal of three screws. Can be furnished in an inclosure or as a skeleton drum with mounting plate for built-in applications on machines. Applicable to any type of single phase, polyphase or d.c. motor. Can also be used as three pole, double throw switch by removing jumpers. Nominal 8 hr. rating is 15 amp. Ratings for single phase, 1 hp., 110 volts and $1\frac{1}{2}$ hp., 220 volts. For polyphase, $1\frac{1}{2}$ hp., 110 volts; 2 hp., 220, 440 or 550 volts. For d.c., 1 hp., 115 or 230 volts. Cutler-Hammer, Inc., 12th & St. Paul St., Milwaukee, Wis.



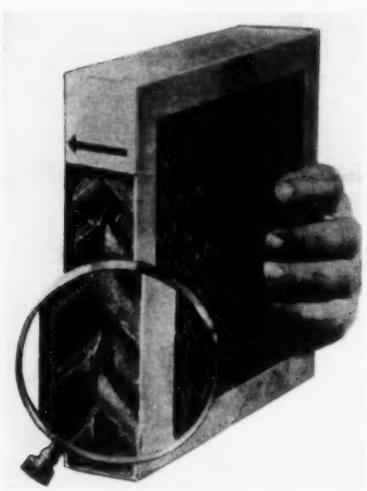


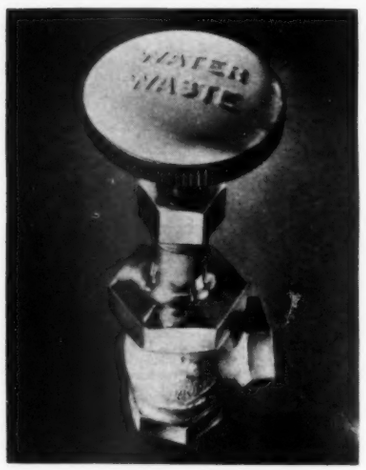
Adjustable Motor Mountings

For vertical drives where the motor pulley is above the driven pulley in order to allow maximum clearance from the floor. This mounting permits a range in selection of pulley sizes, belt lengths, and driven speeds. Correct belt tension is maintained by the use of springs under the motor shelf. Adjustable horizontal drives for motor mountings are also available. Rockwood Mfg. Co., 113-125 N. Green St., Chicago, Ill.

Air Filter

Made of corrugated fiber board and is of the replacement type. Two wafers are placed together so that the cellular passages in the two boards, cut at 45 deg., form a 90 deg. V-shaped passage. These angles cause the air flow to change direction twice and to scrub along the sides of the passages. The entire filter is coated with a special compound that catches the dust. It is said that the coating does not become rancid and remains tacky at —10 deg. F., and does not drip at 180 deg. F. Used in air conditioning and ventilating systems, warm air furnaces, window ventilators, air compressors and internal combustion engines. American Radiator & Standard Sanitary Corp., 40 West 40th St., New York, N. Y.

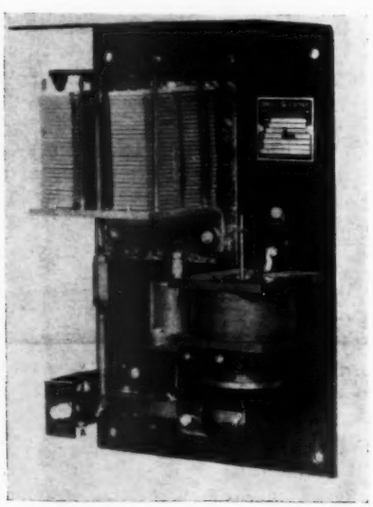




Colored Valve Wheels

For instant recognition of pipe lines carrying steam, water, air or gases. Made of molded plastic material in five standard colors—blue, red, black, green, and gray. Available unmarked or with five standard service markings molded in relief. It is said that the use of such wheels prevents errors and delays. Jenkins Bros., 80 White St., New York, N. Y.

Automatic Voltage Adjuster



For use with small a.c. generators, synchronous motors and condensers and d.c. generators, when voltage-regulating requirements are not too exacting. Consists of a voltage-sensitive element of movable-core solenoid type, operating directly through levers, a wide-range, quick-acting rheostat. The rheostat is connected in the exciter shunt field circuit, any change of voltage being corrected by direct action of the solenoid on the rheostat. The solenoid is used for either a.c. or d.c., excited through a fixed resistor from the generator armature potential. Applicable to small constant-speed a.c. generators having one, two or three phases and with frequencies of 25 to 125 cycles. Suitable for panel and bracket mounting, or may be placed in any convenient location. General Electric Co., Schenectady, N. Y.

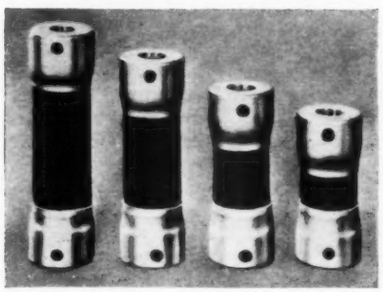
Blueprinter

Floor model 200 is arranged with washing and fixing trays and drying board that can be slid back into the base of the machine. The use of an Angstrom incandescent lamp, operated by a time switch, makes it possible to plug in on any 110 volt a.c. or d.c. light socket. Exposure time is $\frac{3}{4}$ to $1\frac{1}{2}$ minutes and the machine has a capacity of 18x24 in. Milligan & Wright Co., 4628 Prospect Ave., Cleveland, Ohio.

Flexible Coupling

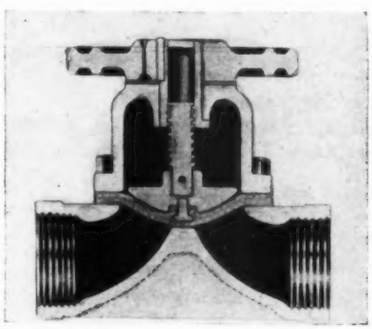
Improved type of drive coupling for fractional hp. motors, said to eliminate transmission of noise and torque vibration from motor to driven shaft. Coupling is made of flexible rubber, treated to resist action of oils. Made in various lengths to eliminate extra cost of motor shaft extensions. Claimed to operate under reasonable lateral and angular misalignment without binding, friction or noise, and is suitable with spring cushioned motors, either base or flange mounted. Available in lengths upwards of $2\frac{1}{2}$ in. with any combination of bores $\frac{5}{16}$, $\frac{3}{8}$, $\frac{7}{16}$ and

½ in. For use on oil burners, stokers, printing equipment, small pump units, bakery machines and similar equipment. Guardian Utilities Co., 1923 East 46th St., Chicago, Ill.



Diaphragm Valve

Is made in two units with a composition diaphragm separating the body and bonnet. The diaphragm forms a seal when the valve is closed and keeps the liquids being handled from coming in contact with the working parts of the bonnet. No gate, seat rings or stuffing boxes are required. The diaphragm is made of a resilient composition, said to resist wear, abrasion and corrosion. The valve body may be made of cast iron, stainless steel, bronze or of ceramic materials and lined with rubber, lead or glass. The valve is used for chemi-



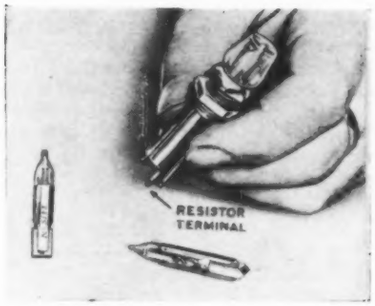
cals, food products, air, gas, oils or water. Screw or flange types are available in sizes from ½ in. upwards. Hills-McCanna Co., 2349-59 Nelson St., Chicago, Ill.

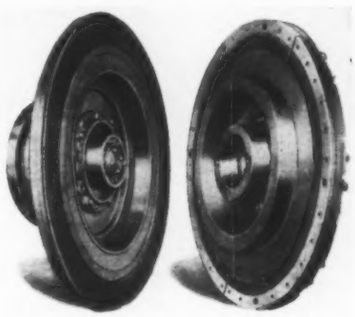
Indicator Tattelites

Are small neon pilot lights operating on voltages of 90 to 250 volts a.c. or d.c. These lights are used to indicate operation of various electrical instruments when directly or remotely controlled or to indicate open circuits, switches or blown fuses. Rated to consume 1/1000 amp. and not to be affected by vibration. Equipped with octagonal shaped bases or with clear phenolic resin caps for dead front panel type mountings. Being only 1 in. long and ¼ in. dia., they can be used where space is limited. Littelfuse Laboratories, 4507 Ravenswood Ave., Chicago, Ill.

Magnetic Clutch

General purpose magnetic clutch in which the friction faces are adjustable for wear to assure uniform lining engagement. A floating magnet armature is used making it impossible to score the magnet pole faces even though proper adjustment of lining is not maintained. The magnet coil is removable and can be replaced as a unit. The clutch has a pilot bearing and lining wear indicator. Cutler-Hammer, Inc., 12th & St. Paul Ave., Milwaukee, Wis.





MANUFACTURERS' PUBLICATIONS

"Alcoa Aluminum and Its Alloys"—Aluminum Company of America. Booklet, 91 pages, 5¼x8¼ in. General information of aluminum, wrought alloys, physical properties, heat-treatable alloys, extruded sections, machinability, corrosion resistance and casting alloys. Contains an appendix of 39 tables giving compositions, mechanical properties of aluminum in all forms, tolerances on various shapes and commercial sizes for round tubing.

Chain and Belt Conveyors—Chain Belt Co., 1600 W. Bruce St., Milwaukee, Wis. Bulletin No. 260, "How to Handle It," 25 pages, 8½x11 in. Showing pictorially 44 applications of Rex chain and belt conveyors for numerous industries for handling various materials, including automotive parts, processed food, packages, coal, crushed stone, grain, lumber, woodpulp and paper.

Counting Devices — Veeder-Root, Inc., Hartford, Conn. Catalog, 14 pages, 9x12 in. Describes how counting devices can be used to increase utility of product, listing a variety of 54 items that can be counted, 28 that can be measured and 50 machines to which counters can be attached. Contains photographs of numerous counters manufactured, including a computer for gasoline dispensing pumps.

Drop Forgings—Kropp Forge Co., 5301 W. Roosevelt Road, Chicago, Ill. Folder, 4 pages, 8½x11 in. Examples shown of forged work include cams, levers, eccentrics, arms, gears, pinions, crankshafts, piston rods and flanges. Equipment shown for machining and heat-treating facilities.

Electrical Instruments—Roller-Smith Co., 233 Broadway, New York, N. Y. Catalog No. 48, 19 pages, 8½x11 in. Switchboard and panel instruments in round and rectangular patterns. Photographs and dimensional mounting drawings are shown for d.c. ammeters, voltmeters, galvanometers, pyrometers and shunts. Similar photographs and outline drawings also shown for a.c. ammeters, voltmeters, single and polyphase wattmeters, frequency meters, power factor meters and synchroscopes. Thermo-couple ammeters are also included. Catalog No. 8 shows installations of air and oil circuit breakers.

Gears—Meisel Press Mfg. Co., 944 Dorchester Ave., Boston, Mass. Booklet, "Gear Craftsmanship," 12 pages, 8½x11 in. A discussion of the value of quality in gears, including several short chapters under the headings of "A Panorama of the Historical Progress of a Gear Manufacturer," "Ideas of Quality Gears" and "The Technical Craftsmanship of Quality Gears."

Insulation—Joseph C. Ray & Co., 5745 West Ohio St., Chicago, Ill. "Electrical Application of Plastics" and "Moisture Proofing." Two leaflets, 4 pages each, 8½x11 in. The first deals with electrical insulation design in which treated plastics are used to overcome the effects of corona, streamers and arcing. The second deals with various moisture resisting materials, and processes as applied to articles made of wood, industrial coils, transformer coils and condensers.

Meehanite—Meehanite Metal Corp., Pittsburgh, Pa. Bulletin No. 4, 6

pages, 8½x11 in. Shows wear and erosion resistance by heat-treatment and chilling, with photographs and charts. Also lists types of service and service life of numerous items so treated. Various finished details such as cams, sprockets, indexing plates, clutches and brakes, and pump parts are shown.

Motors—Century Electric Co., 1806 Pine St., St. Louis, Mo. Booklet, 8 pages, 8½x11 in. Polyphase motors, 1/6 to 600 hp., including open, inclosed, explosion proof, totally inclosed and fan cooled, gear, splash proof, multi-speed, and general purpose motors with special characteristics of each.

Motors—Diehl Mfg. Co., Elizabethport, N. J. Booklet, 18 pages, 8½x11 in. Simplified catalog and price list of motors, generators and ventilating equipment with photographs of various types of motors and other applications. Lists speeds of ½ to 50 hp. motors.

Motors — Fairbanks-Morse & Co., Chicago, Ill. "Polyphase Squirrel-Cage Induction Motors," 8 pages, 8½x11 in., shows construction of and explains how various components are made and what materials are used. Motor characteristics for numerous types of driven machinery are listed. Rotor and slot construction are illustrated with line drawings.

Name Plates—Fox Company, Fox Bldg., Cincinnati, Ohio. Folder, 4 pages, 8½x11 in. Pictures are shown of name plates for automobiles and stoves, escutcheons for radios, dials for machine tools and badges for various purposes.

Potentiometer Pyrometers — The Brown Instrument Co., Wayne & Roberts Aves., Philadelphia, Pa. Folder, 8 pages, 8½x11 in. Explaining with photographs the galvanometer, motor, slide wire and drive mechanism of temperature controlling, indicating and recording instruments.

Shaker — Ajax Flexible Coupling Co., Westfield, N. Y. Leaflet, 4 pages, 8½x11 in. "Shaler Shaker" for mounting directly on screen, sieve, shoe, conveyor spout or other devices. Produces a back-and-forth oscillating movement without being fastened to frame, floor or part of building. Cross-section line drawings show construction and dimensions for four sizes are given with explanation of mechanical details.

Stainless Steel — Republic Steel Corp., Massillon, Ohio. Folder, "Stainless Steel for Textile Equipment," 6 pages, 8½x11 in. Describing the use of "Enduro" stainless steel for dyeing and bleaching solutions with comparative tests for acid chrome colors. Also explains fabrication, riveting, welding and machining properties. Photographs of various dyeing equipment are included.

Tachometers—General Electric Co., Schenectady, N. Y. Folder No. 8872, 8½x11 in. Composed of generator and indicating instruments for use as in airplanes, recording up to 3,500 r.p.m. Schematic wiring diagram and line drawings with dimensions accompany the text.

Temperature Control Equipment—The Hart Mfg. Co., Hartford, Conn. Bulletin No. 13-A, 20 pages, 8½x11 in. Direct break indicating and non-indicating thermostats of the silver contact and mercury tube type with helical or flat spiral thermostatic element. Numerous types of mountings are listed. For a.c. and d.c. with various voltages and amperage. Hot water thermostats are also listed. Dimensioned line diagrams for mounting and a method of calibration are shown.

Thermometers—Leeds & Northrup Co., 4900 Stenton Ave., Philadelphia, Pa. Bulletin 4001, 24 pages, 7½x10½ in. Three-lead, null-type electrical-resistance thermometers for regulation of air-conditioning systems. Photographs, diagrams, charts and outline drawings with dimensions for mounting are shown.

"What Formica Is"—The Formica Insulation Co., Cincinnati, Ohio. Booklet, 31 pages, 3¼x6. Describes manufacturing processes and shows pictures of parts used in a number of industries. Gives a list of colors, grades, shapes, bases used and chemical resistances of material.

BOOKS AND BULLETINS

S.A.E. Handbook

Society of Automotive Engineers, Inc., 29 West 39th St., New York, N. Y. 724 pages, 5½x8½ in. Blue clothboard covers. Price $2.50 to members, $5 to non-members.

The 1935 edition includes all current standards and recommended practices adopted by the society. The book is divided into ten sections, among which the iron and steel specifications have been revised. This section, consisting of 195 pages, embraces chemical and physical properties, grain size charts, heat-treatments and testing. In the same section a revision of non-ferrous metal specifications is also included, consisting of new data on aluminum alloys, brass, bronze and copper alloys, white metal bearings, solders, zinc alloy die-castings, rare metals, protective coatings for aluminum and nickel and chromium plating.

New and revised sections are also included relative to the classification of screw threads and fits with tables of Class 2 and 3 fits for special pitches, crank case oils, automobile head light laboratory test specifications, specifications of commercial truck loads and dimensional limitations, and cancelled tire and rim sizes.

Handbook of Chemistry and Physics

19th Edition

Charles D. Hodgman. 1,934 pages, 4x6 in. Black fabricoid covers. Published by Chemical Rubber Publishing Co., Cleveland, Ohio. Price $6.

The latest edition of this handbook is divided into five sections: Mathematical Tables, Properties and Physical Constants, General Chemical Tables, Heat and Electricity, Quantities and Units. New tables appearing in this edition include logarithms of trigonometric functions in decimal fractions for both radians and degrees, density of moist air, fusibility scale, thermodynamic properties, and heat of combustion of liquid fuels. An extensive table on X-ray crystallographic data also appears in this edition for the first time giving the type of structure, space group and crystal dimensions for more than 1,300 compounds.

Revisions have been made in a number of tables, including integrals, exponential and hyperbolic functions, numerical constants, hardness, specific heat, resistance of wires, melting and boiling points of the elements.

Physical constants for 4,000 metal and inorganic compounds and 4,000 organic compounds continue to form the most important section of the handbook, occupying 956 pages. Mathematical tables require 274 pages; tables on heat cover 146 pages; sound, electricity, and magnetism 114 pages; and 70 pages of tables on light.

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Tin Research

Seven recent reports, listed below, are published by the International Tin Research and Development Council. Copies are available free from L. J. Tavener, 149 Broadway, New York, N. Y.

"The Determination of the Porosity of Tin Coatings on Steel," Series A, No. 7, 9 pages.

"Tin Plate: Some Fundamental Considerations," Series A, No. 14, 16 pages.

"Some Properties of Tin Containing Small Amounts of Aluminum, Manganese and Bismuth," Series A, No. 15, 16 pages.

"Type Metal Alloys," Series A, No. 16, 41 pages.

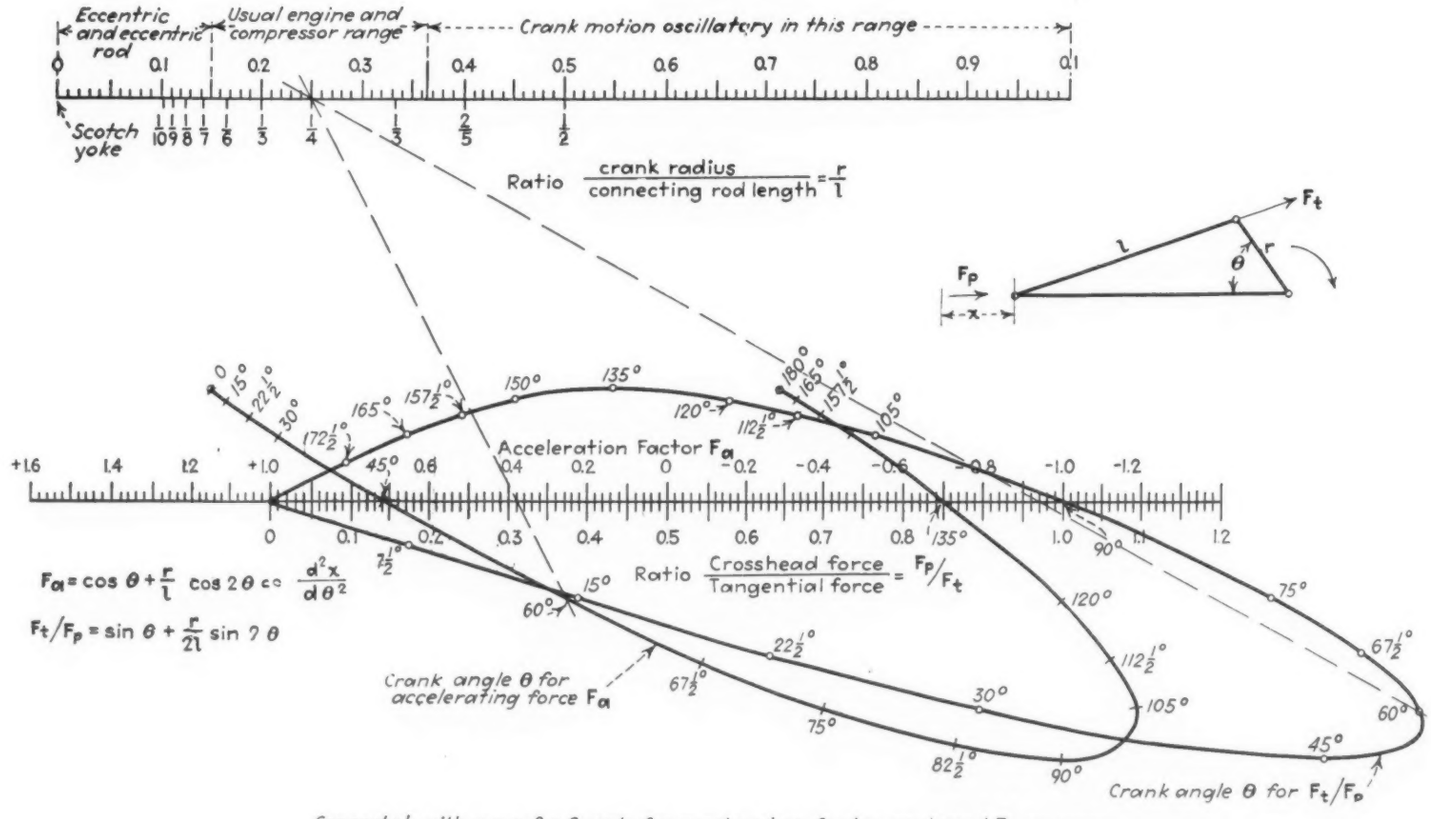
"Factors Influencing the Foundation and Structure of Hot-Dipped Tin Coatings," Series A, No. 17, 9 pages.

"A Study of the Yellow Stain on Tinplates," Series D, No. 1, 11 pages.

"Tinplate and Canning in Great Britain," Bulletin No. 1, 81 pages.

Turning Effort and Crosshead Acceleration in Crank Drives

ROLAND V. HUTCHINSON
Lansing, Mich.

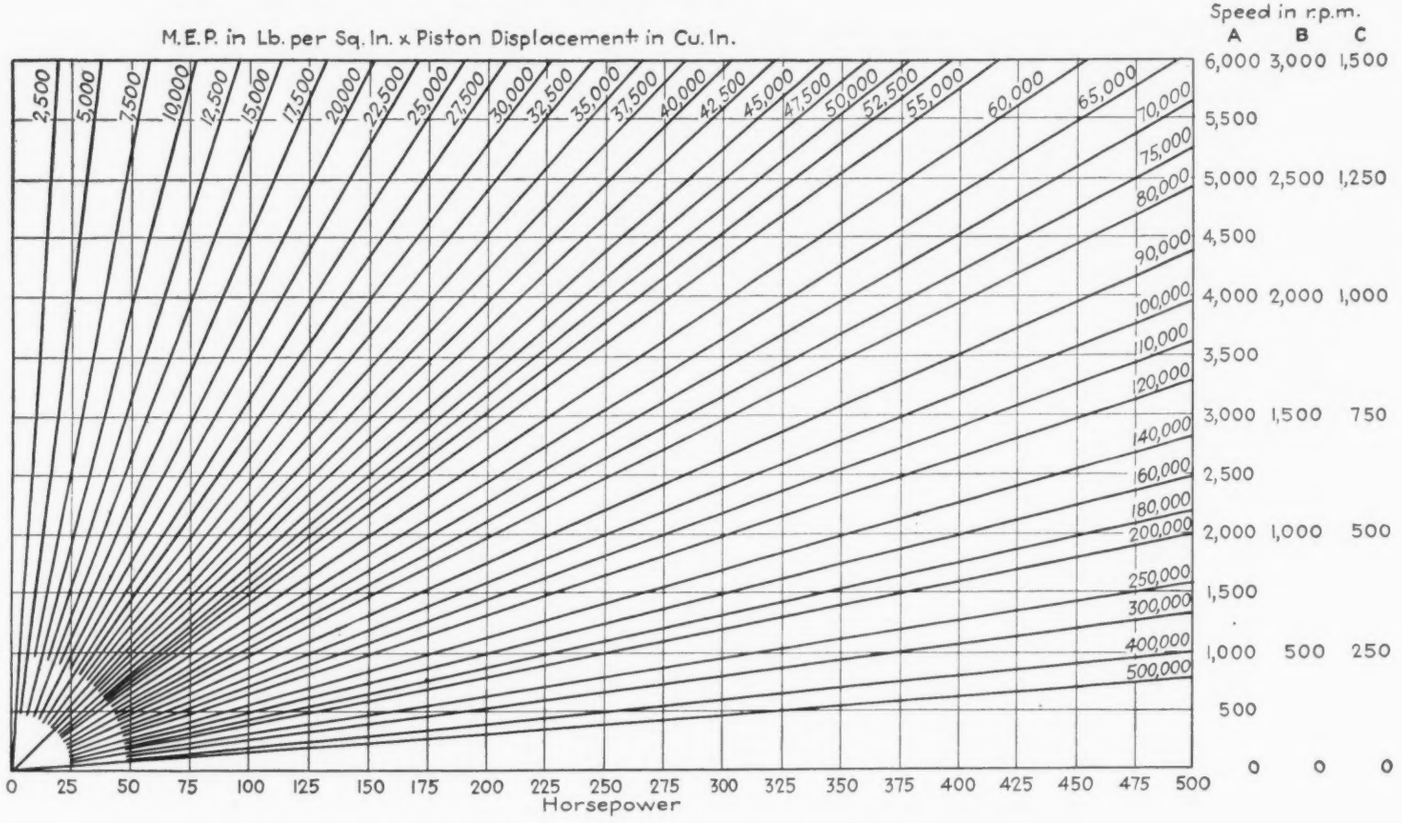

Eccentric and eccentric rod
Usual engine and compressor range
Crank motion oscillatory in this range
Scotch yoke
Ratio crank radius / connecting rod length = r/l
Ft
Fp
l
r
θ
x
Acceleration Factor Fα
Fα = cos θ + r/l cos 2θ ... d²x/dθ²
Ft/Fp = sin θ + r/2l sin 2θ
Ratio Crosshead force / Tangential force = Fp/Ft
Crank angle θ for accelerating force Fα
Crank angle θ for Ft/Fp

Connect r/l with curve for θ scale for acceleration factor and read F_α on upper graduations. Connect r/l with θ scale for force ratio and read F_t/F_p on lower graduations

The dotted lines show that for a ratio of $\frac{r}{l}=\frac{1}{4}$, and θ = 60°, the acceleration factor F_α is 0.38, and the ratio F_t/F_p is 0.965

Engine Horsepower for Medium and High Speeds

WILLIS G. MEYERS
Detroit, Mich.



Use column **A** for 4-cycle engines, use column **B** for two-cycle engines, pumps, compressors, etc.-use column **C** for two-cycle double acting engines. If indicated mean effective pressure (M.E.P.) is given, result will be in indicated horsepower. Multiply piston displacement by M.E.P. and select ray coresponding to product. Locate point of intersection with horizontal line representing desired speed and project downward upon horsepower scale